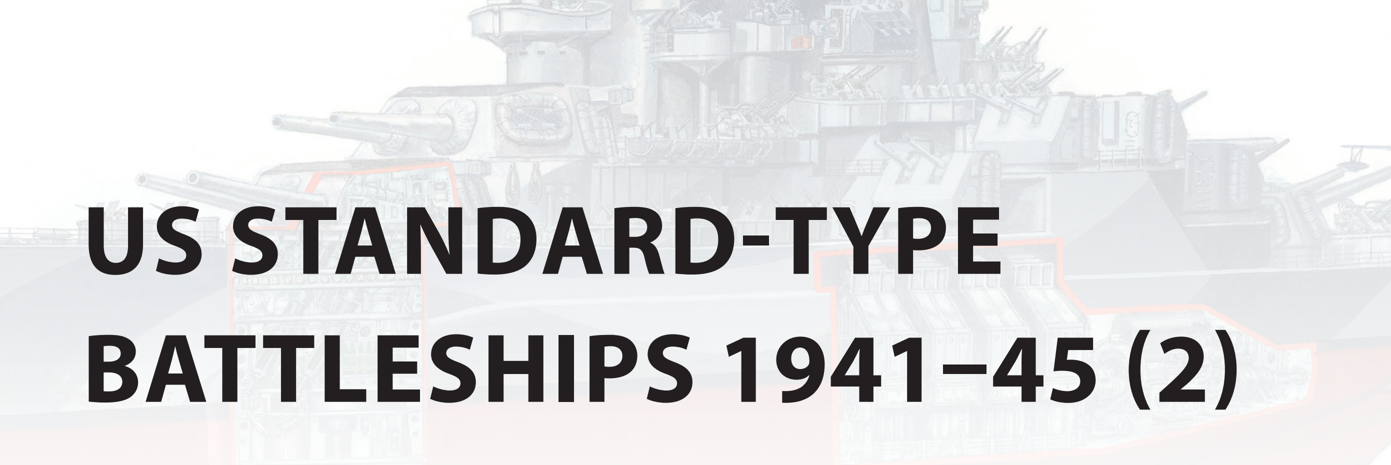
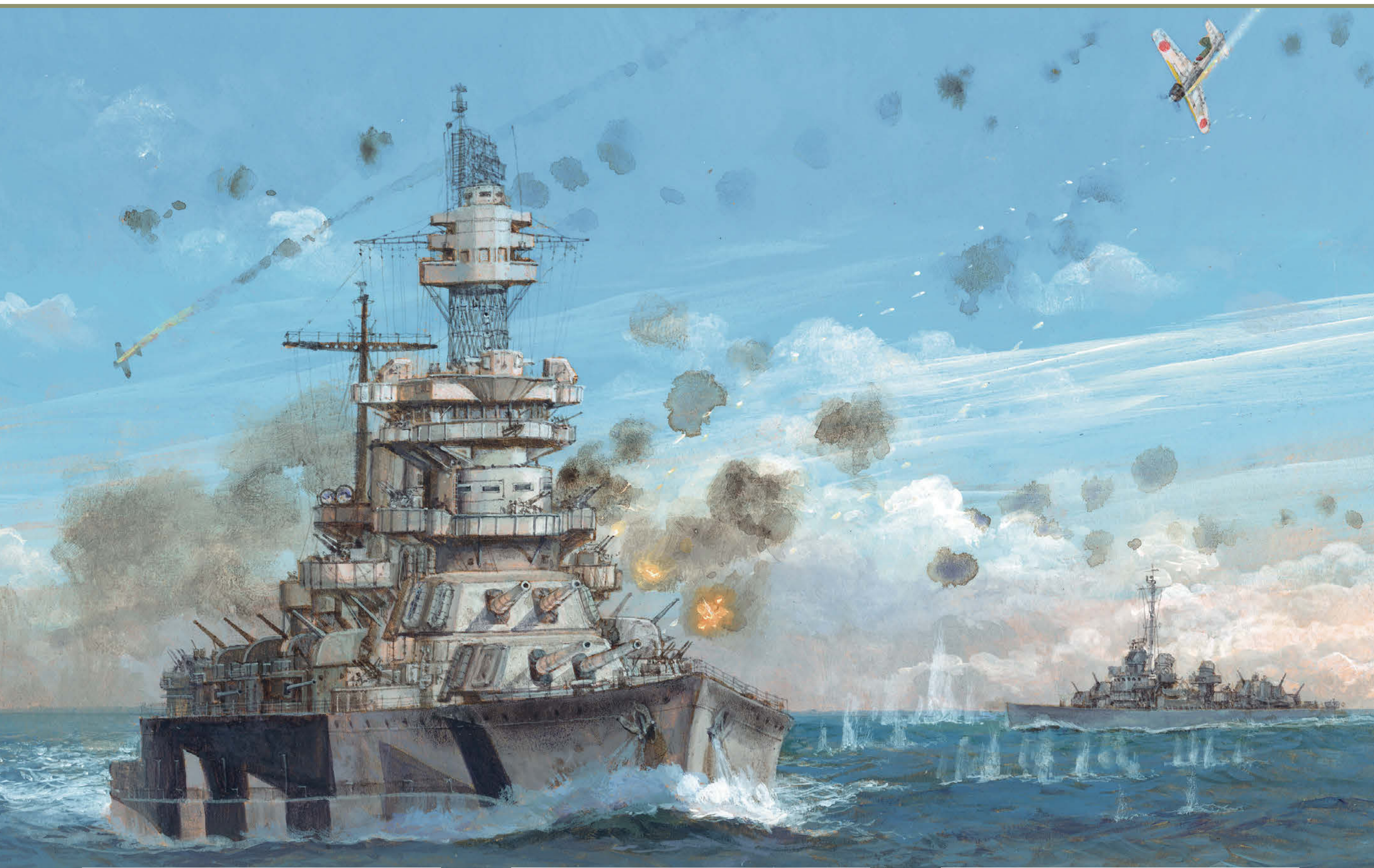


US STANDARD-TYPE BATTLESHIPS 1941–45 (2)

Tennessee, Colorado and Unbuilt Classes



MARK STILLE

ILLUSTRATED BY PAUL WRIGHT

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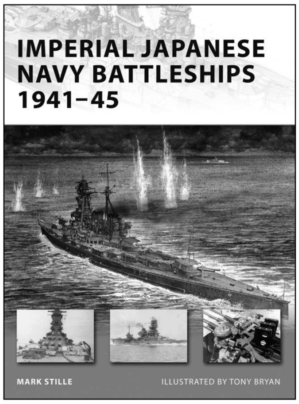
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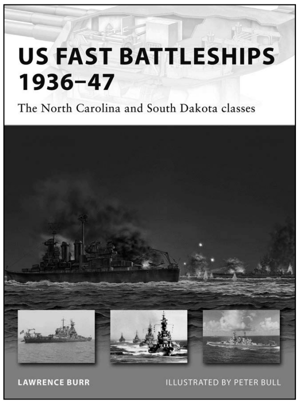
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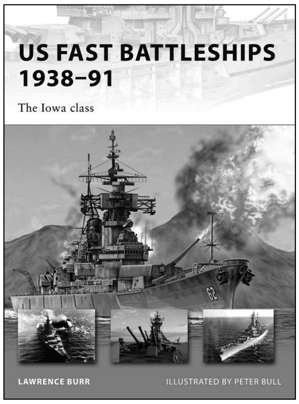
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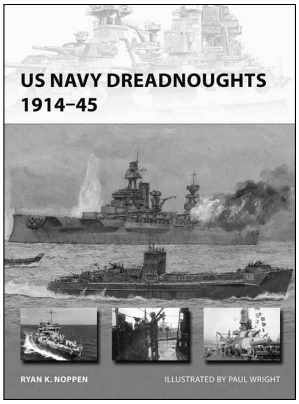
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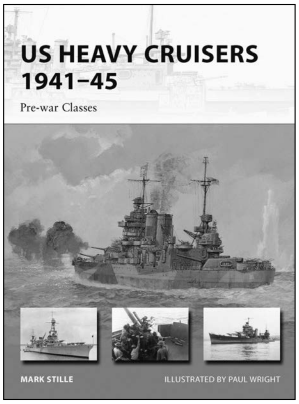
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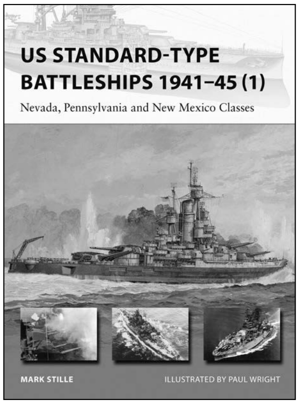
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US STANDARD-TYPE BATTLESHIPS 1941–45 (2)

Tennessee, Colorado and Unbuilt Classes

MARK STILLE ILLUSTRATED BY PAUL WRIGHT

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Title page image: *California* on full-power trials in 1921 just before being commissioned. Even under full steam at 21 knots, the ship had an inferior speed compared to foreign battleships.

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US STANDARD-TYPE BATTLESHIPS 1941–45 (2)

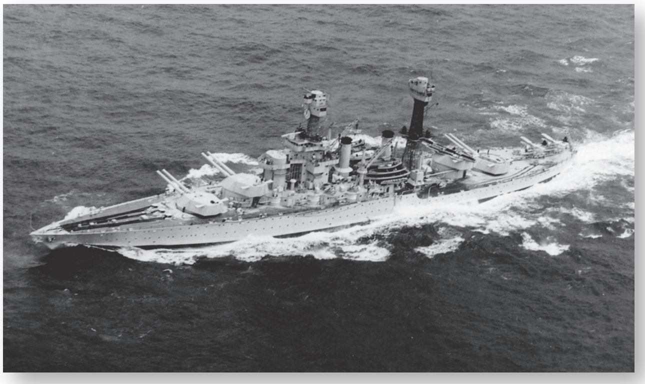
TENNESSEE, COLORADO AND UNBUILT CLASSES

INTRODUCTION

Of the 17 battleships that the United States Navy (USN) went to war with in December 1941, 15 of these were older ships dating back to 1912. The most recent of these were the ships of the Tennessee and Colorado classes which constituted five of these battleships. These ships, called the “Big Five” by the USN, had active combat careers in spite of their age. In addition to these two classes, this book covers the ships of the unfinished South Dakota class of battleships and the Lexington class of battlecruisers. Construction of these ships had been started after World War I, but was cancelled after the Washington Naval Treaty of 1922. These overlooked ships were significant since the South Dakota class had the potential to be the most powerful battleship of the interwar period and the Lexington class was the only class of battlecruiser ever begun by the USN. The three preceding classes of dreadnoughts (the Nevada, Pennsylvania, and New Mexico classes) are covered in New Vanguard 220: *US Standard-Type Battleships 1941–45 (1)*.

US WORLD WAR II STRATEGY AND THE ROLE OF THE BATTLESHIP

The USN’s pre-war plans for a war in the Pacific reflected the centrality of its battleships. When the decisive battle took place against the Imperial Japanese Navy (IJN) during the last phase of the USN’s planned advance across the Pacific toward Japan, the duel of battle fleets would decide the victor. In this climactic battle, the ships of the Tennessee and Colorado classes were expected to play a prominent role since the Big Five were the most modern battleships in the fleet. They were also the best suited to execute the USN’s desire to fight the IJN’s battle line at long ranges. The Big Five were assessed to possess unparalleled capabilities at extreme range (greater than 27,000 yards) while the



Colorado underway in April 1937 getting ready to conduct gunnery practice with her main battery. All four 16-inch turrets are trained to starboard, along with the rangefinder on top of the superstructure. The float plane from the catapult on top of Turret Number 3 has been launched to provide spotting. The USN banked heavily on its ability to conduct accurate long-range fire, and the *Colorado* class was judged to be extremely effective in this respect.

previous classes of Standard-type battleships were only rated to have capabilities at ranges inside 21,000 yards.

In spite of the grand expectations for the role of the USN's older battleships, during the war these ships were immediately relegated to secondary duties. There were two primary reasons for this. First, the attack on Pearl Harbor demonstrated the vulnerability of the Standard-type battleships to air attack. Second, these ships had such low speed that they were totally unsuited for the demands of the new type of war which would dominate the war in the Pacific – far-ranging attacks by fast carrier task forces. Given their unsuitability for carrier duties, and the much greater range and offensive power of the carrier, the USN's older battleships were given secondary roles.

The Standard-type Battleships' New Role

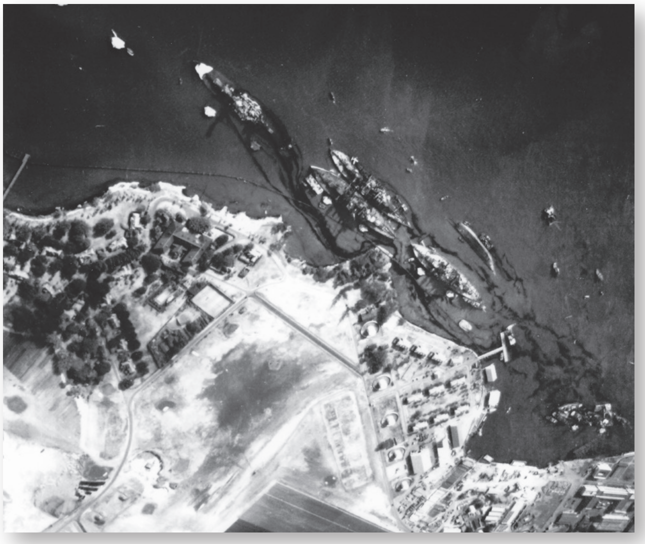
During World War II, the predominant role for the USN's older battleships was supporting amphibious assaults. In the Atlantic, one of the Standard-type battleships joined the oldest of the USN's battleships to support the Normandy landings and the attack on southern France in 1944. In the Pacific, the older battleships were continually used in this role from the invasion of Attu in 1943 through to the end of the war.

The tenacious Japanese defenders of the many islands and atolls assaulted by the Americans soon learned to dig in deeply to mitigate the effects of overwhelming American firepower. As the level of entrenchment by the Japanese increased throughout the war, the importance of the battleships increased since their main guns had the power to destroy all but the most dug-in defender. Additionally, their 5-inch secondary batteries were useful for providing quick reaction firepower, and the greater trajectory of the 5-inch/38 guns was useful in reaching behind terrain features.

Typically, the USN invasion force, led by the battleships, would conduct pre-invasion softening-up of the defenses prior to the landings. Photo reconnaissance provided the location of defensive positions which would be systematically attacked. The early invasions featured a very short pre-invasion bombardment which was shown to be inadequate. The importance of adequate pre-invasion preparations was learned at Tarawa Atoll in November 1943. Here, at Betio Island on November 20, the bombardment force of three battleships, four cruisers, and several destroyers, was allotted only 2.5 hours for the softening-up. Over 2,400 tons of explosives were dumped on the small 291-acre island which caused heavy casualties among the Japanese defenders, but the Marines still faced a functional defense as they headed toward the island. It took three days of bitter fighting with high casualties to secure the small island.

Learning from this hard-won lesson, the USN lengthened the period of pre-invasion bombardment. Just a few months later at the invasion of the Roi and Namur Islands at Kwajalein Atoll, the pre-invasion bombardment was increased to 6,000 tons of explosives and the battleships closed to

Four of the Big Five battleships were caught in Pearl Harbor on December 7, 1941. This view from December 10 shows the devastation of the USN's battle line. The battleship at the top of the photograph is *California* which rests on the harbor floor. The next pair of battleships is the capsized *Oklahoma* with *Maryland* inboard. Aft of those are *West Virginia* with *Tennessee* inboard. The blasted *Arizona* is the battleship in the lower part of the photo.



This iconic photo shows *Tennessee* providing covering fire against Japanese positions on Okinawa on April 1, 1945 as Marines on amphibious tractors head for the beach.

under one mile from their targets. On Saipan in June 1944, eight battleships, 11 heavy and light cruisers, and 26 destroyers conducted a carefully planned two-day bombardment. The adjacent island of Tinian was subjected to 43 days of preliminary naval and air bombardment before the Marines landed on July 24. The most prolonged preliminary naval bombardment of the war – for 13 days – was employed against Guam. The pre-invasion bombardment of Iwo Jima was three days prior to the landing on February 19, 1945, but the limitations of naval gunfire were again revealed since many of the defenders were in deep caves, making them fairly safe even from battleship guns. On Okinawa the pre-invasion preparations were commenced on March 26 leading to the April 1, 1945 landing and were conducted by ten battleships, ten cruisers, and 24 destroyers. In this case, the preliminary bombardment was wasted since the Japanese elected to pull back from the invasion beaches to fight an extended battle of attrition on the southern part of the island.

Once ashore, the landing force depended on the invasion fleet for sustained gunfire support. The Japanese adopted a defense-in-depth strategy after their defeat on Saipan, trying to extend the length of the island battles to inflict maximum American casualties. This required the battleships to be constantly on-call to engage targets as they were identified and to be ready to assist in the repelling of the occasional Japanese counterattack. Their fire was guided by Gunfire Liaison Officers (GLOs) who were trained in the application of naval gunfire and were provided with the appropriate communications gear. With the help of the GLOs, gunfire support, even with large-caliber battleship guns, could be delivered in relatively close proximity to friendly troops.

During the latter part of the war, beginning in the late stages of the invasion of Leyte and climaxing during the campaign for Okinawa, the older battleships were exposed to another threat – kamikazes. In defending against this new threat, the battleship was again ideally suited. By this stage of the war, the battleships were provided with large antiaircraft batteries which accounted for many kamikazes. Against smaller, unarmored ships, the kamikaze was deadly. Against large, armored targets, epitomized by battleships, kamikazes could occasionally inflict extensive topside damage and cause severe personnel losses, but rarely could they inflict severe damage. This allowed the battleships to take kamikaze damage and usually stay on station.

USN Battleship Design Developments

In the USN, the General Board (a group of supposedly unbiased high-ranking admirals at the end of their careers) was the entity responsible for approving warship design. The Board placed a heavy emphasis on ensuring that the battleships of the fleet could operate together. This meant the ships had to have comparable speed and steaming range, similar handling characteristics and comparable ability to absorb damage. This led to a so-called "standard" battleship design which was incrementally improved year after year. Thus, the battleships from the Nevada class to the Colorado class were remarkably similar in their most important characteristics. The General Board was also driven by a desire to create ships that were at least as good as or better than battleships from the United Kingdom, Germany, and increasingly Japan.

The Holy Trinity of battleship design was the combination of firepower, protection, and speed. Any design was a blend of these three competing principal design areas, and any design would have to compromise in some areas to enhance others. The USN's Standard-type battleships emphasized firepower and protection; speed came in a distant third in design considerations.

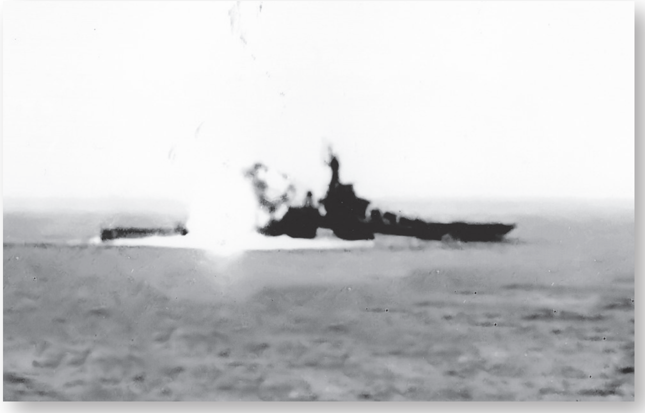
The Tennessee class, the 1916 battleship design, was closely based on the preceding New Mexico class. The two Tennessee class ships had the same main battery with identical numbers and placement of the standard 14-inch gun. The secondary battery was still the 5-inch/51 but, for the first time, all guns were placed above the main deck. The deletion of hull casemates not only made the guns more useful in all types of weather, but gave the ships a cleaner appearance. The clipper bow was also maintained giving the ships a modern look. The cage masts were retained which was a unique USN feature for its battleships. The new class did differ in one respect since it reverted back to a two-stack arrangement.

The Tennessee class continued the USN's "all-or-nothing" protection concept which had been adopted on the Nevada class and used for all subsequent ships. Protection was close to the USN standard in which the maximum depth of the belt armor was equal to the caliber of the main battery. Thus, the belt on the 14-inch gun-equipped Tennessee class was 13.5 inches. On previous USN battleship classes, underwater protection was seen as a major weakness since these ships did not possess dedicated anti-torpedo defenses. The Tennessee class was given a system of voids and fuel-filled spaces between longitudinal bulkheads designed to dissipate the effects of a torpedo or mine explosion.

The Colorado class was the last of the Standard-type battleships to enter service. It used the same hull dimensions, engineering plant, and protection scheme of the Tennessee class but substituted the new 16-inch/45 gun for the previous 14-inch/50. This move gave the new class greater hitting power and was required to keep up with new Japanese and British designs which were also moving to a 16-inch main battery.

While the five previous classes of battleships had been largely uniform in capability and size, the General Board had wanted to develop a ship of greater size and capabilities, but it was clear that Congress would not support the funding of larger ships. Developments in Europe demonstrated the need to stay ahead of foreign rivals, so approval was finally given to design a ship which was a clear jump ahead, not an evolutionary step forward. This was the South Dakota class, designed during World War I but not laid down until after the war.

Colorado bombarding Tarawa on November 20, 1943; the photo was taken from *Maryland*. Despite the massive application of firepower against the tiny atoll half the size of New York City's Central Park, the pre-landing bombardment was a failure which led to significant changes in USN shore bombardment doctrine.



The South Dakotas were essentially enlarged versions of the Colorados with the primary difference being the substitution of triple 16-inch gun turrets for the existing twin turrets.

In addition, speed was increased by two knots, but no attempt was made to meet or exceed the assessed speed of foreign designs. Protection was also essentially unchanged from previous designs since American steel manufacturers had stated that 13.5-inch armor plates was the maximum thickness which could be made with consistent quality.

The real difference in the new design was a greater hitting power in the form of the much more powerful 16-inch/50 gun, compared to the 16-inch/45 on the Colorado class. The maximum elevation of the main battery was increased to 40 degrees for more range. The secondary battery was upgraded to the new 6-inch/53 gun from the previous 5-inch/51. All considered, the South Dakota class would have been the most powerful battleship afloat had it entered service.

USN Battleship Weapons

The standard main battery gun from the Nevada to Tennessee classes was the 14-inch gun. The Tennessee class carried the 14-inch/50 gun. This generated a greater muzzle velocity than the earlier 14-inch/45 version, thus producing a longer range and greater penetration at the expense of increased barrel wear. The triple turret had a maximum 30 degrees of elevation. It could fire an armor-piercing (AP) shell weighing 1,500 pounds or a 1,275-pound high capacity (HC) shell. Maximum range for the lighter HC shell was 36,600 yards, and the AP shells could reach targets at 34,000–35,000 yards range.

For the Colorado class, the USN made the jump to a 16-inch main battery. This was a 16-inch/45 weapon which came in several variants with the original Mark 1 being installed upon the ships' construction and the Mark 5 and 8 variants being introduced when the guns were re-lined. About 40 of these weapons were built.

Design work was completed in August 1913, and the gun was first test-fired in July 1914. However, the first production order was not made until the start of 1918. The decision was made to mount the new 16-inch gun in twin turrets; even with only eight 16-inch guns, the Colorado class possessed the same broadside as the 12-gun 14-inch Tennessee class. The 16-inch turret weighed 927 tons and each of the guns was placed in a separate cradle with a fireproof bulkhead between them. For the heavier 2,240-pound AP shell, the maximum range was 35,000 yards at the full 30-degree elevation. For the 1,900-pound HC shell, the range was 34,900 yards.

Colorado conducting a 16-inch gun shoot in October 1943. The 16-inch/45 gun was a successful weapon able to fire a 2,240-pound armor-piercing round or a 1,900-pound high explosive shell.

The real difference between the 14-inch and the 16-inch guns was in their penetrative power. The heavier shell of the larger 16-inch gun gave it considerably more hitting power. The 14-inch had the ability to penetrate 13.6 inches of armor at 12,000 yards; in comparison, the 16-inch could penetrate 18.9 inches at 12,000 yards.

The 16-inch/50 gun was intended for the South Dakota class battleships and the Lexington class battlecruisers. These guns were an improvement over the 16-inch weapons mounted on the Colorado class in respect to range. They were never mounted on any USN battleship, though for a time it looked like they were destined for the fast battleships *Iowa* and *New Jersey*. They did see service as shore defense guns under Army control, and proved successful in that role.

Tennessee and Colorado Class Main and Secondary Guns

Type	**Muzzle Velocity** (ft/sec)	**Max Range** (yards)	**Rate of Fire**
16-inch/50	2,650	45,100	1–2 rds/min
16-inch/45	2,520	35,000	1–2 rds/min
14-inch/50	2,700	36,600	1–2 rds/min
5-inch/51	3,150	15,850	8–9 rds/min
5-inch/25	2,110	14,500	14 rds/min
5-inch/38	2,600	18,200	15–20 rds/min

Since the Standard-type battleships were designed in an era in which there was no real air threat to capital ships, the secondary batteries of these ships were dedicated to defending against destroyer attack. This was an important design consideration since even early destroyers were a real threat to battleships as their torpedoes could defeat the underwater protection of most battleships. The USN believed that its 5-inch/51 secondary battery gun had a longer range than Japanese torpedoes since it was assumed that IJN torpedoes had comparable capabilities to USN torpedoes of the time. The USN remained totally ignorant of the development of the Japanese oxygen-propelled Type 93 torpedo with its maximum range of 43,700 yards. The assumed greater range of the 5-inch/51 gun over torpedoes made it likely that enemy destroyers would attack at night, and thus USN battleships mounted a number of powerful searchlights.

In the 1920s, the threat from air attack began to take shape, so the USN began augmenting the antiaircraft batteries of its battleships. This led to an inefficient arrangement in which the battleships were forced to carry a separate battery for anti-surface protection and a separate battery for antiaircraft protection. The development of the 5-inch/38 gun, the best dual-purpose gun of World War II, meant that one battery could perform both roles. All but one of the Big Five ended the war with a 5-inch/38 dual-purpose secondary battery.

USN battleships began the war with a deficient antiaircraft suite, but this deficiency was shared by the battleships of every other naval power. From a pre-war antiaircraft suite of eight 5-inch/25 guns for intermediate protection and a short-range suite of 1.1-inch quad mounts or 3-inch guns and a handful of .50 caliber machine guns intended to defeat dive-bomber attacks, these ships were given vastly improved antiaircraft capabilities over the course of the war. The four most modernized ships of the Big Five (all except *Colorado*) were given the excellent dual-purpose 5-inch/38s in twin mounts, and large numbers of quad 40mm Bofors mounts and Swiss-designed 20mm Oerlikon guns. Combined with modern fire-control equipment, these ships approached the capabilities of the USN's ten modern battleships. These impressive antiaircraft capabilities gave the ships the ability to contend with conventional Japanese air attack, but could not offer a high degree of protection against kamikazes.

LEFT
In this view, gunners aboard *Colorado* conduct a shore bombardment exercise in November 1943 before the invasion of the Gilberts later that month. The gun is the 5-inch/51 mounted in casemates. Its principal mission was defending the ship against torpedo attack, but it was also useful in a shore bombardment role with a 54-pound high explosive shell. The casemate offered little protection against a direct hit.

RIGHT
Colorado conducting antiaircraft practice with her starboard-side 5-inch/25 guns firing at an unseen target. Note the shields around the single mounts. *Colorado* was the only ship in her class to retain the 5-inch/25 guns until the end of her career. The 5-inch/25's Mk 37 directors with the Mk 4 radar can be seen on the superstructure on either side of the forward cage mast.

Tennessee and Colorado Class Antiaircraft Guns

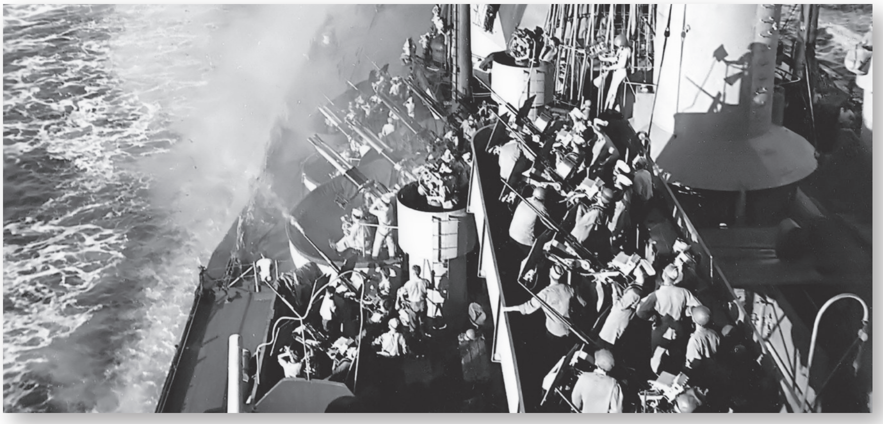
Type	**Muzzle Velocity** (ft/sec)	**Max Range** (yards)	**Rate of Fire** (theoretical)
.50-inch Browning M2 water-cooled machine gun	2,930	7,400	550–700 rds/min
1.1-inch Mk 1/1	2,700	7,400	140 rds/min
20mm Oerlikon	2,740	4,800	450 rds/min
40mm Bofors	2,890	2,890	160 rds/min
3-inch/50	2,700	14,590	15–20 rds/min

USN Battleship Fire Control

The key to generating combat power at sea is effective fire control. The USN devoted great effort to devising a fire-control system able to deal blows at long ranges to utilize the capabilities of its battleship guns. This was a complex problem which had to take into account the range of the target and its movement, as well as its own ship's movement. The USN's battleship fire-control system had several components. The cage masts contained the fire-control directors and facilities for spotting the fall of the ship's shells. The basis for long-range fire was the use of a rangefinder to determine the range to the target, and every USN battleship carried several of these. By 1925, long-range range-finding was performed by the "battle" (armored) Mk 22 coincidence rangefinder fitted in the rear of every main battery turret. There were also two exposed rangefinders fitted above the conning tower and another on the roof of one of the main battery turrets. These were used for secondary battery control, ship's navigation, and flag use.

The heart of USN battleship fire control was the main battery plot. This was located below the conning room and protected by the ship's armor. This is where the analog computer was located which calculated the fire-control solution using inputs from other components of the fire-control system. Three of the modernized Big Five ships were equipped with automatic control which moved the main battery turrets in accordance with directions from the main battery plot by elevation and training drives in the turrets. This allowed a constant aim to be maintained, except in the roughest seas.

An important aspect of effective gunnery was observing the fall of each ship's shells and then making corrections onto the target. This was accomplished by observers on the tallest part of the ship, the cage masts, or better yet, by the ship's spotting aircraft.



The massed starboard-side antiaircraft guns aboard *Colorado* conduct gunnery practice. The guns in the foreground are 20mm single mounts fitted on a gallery built between the ship's stacks. The 20mm was placed in great numbers aboard battleships anywhere that they had a clear firing arc. Note the Mk 14 gun sight on each of the weapons. These weapons had a 1,500-yard effective range making them a last-ditch defensive weapon. Also visible are two quad 40mm mounts with their Mk 51 directors behind them. The 40mm gun was a much more effective weapon since its effective range was 3,000 yards and it fired a larger projectile.

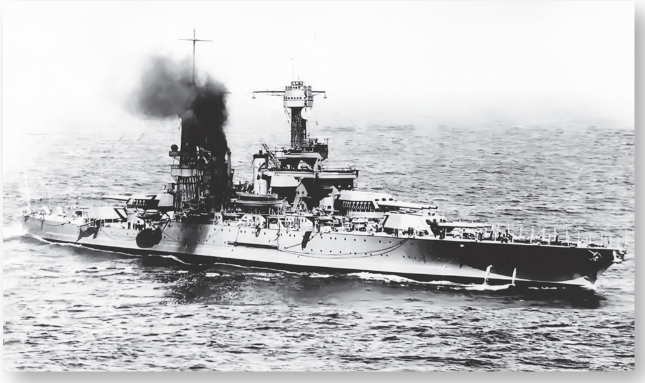
A more effective method to determine range and later the fall of shot was radar. Rangefinders were unreliable since they were dependent on the skill of the user and were affected by weather conditions. The USN emphasized the use of radar as the war progressed. The Mk 3 surface fire-control radar was introduced in late 1941. Conditions were affected by many factors, but it could range a large target between 15,000 and 30,000 yards. The Mk 8 fire-control radar was introduced in 1943 and could reliably range on a large target at 40,000 yards while providing enough precision to display both the target and the splashes of the ship's shells, thus allowing corrections to be made. The introduction of radar changed USN gunnery doctrine from firing ranging salvoes which were then corrected onto the target, to aiming the first salvo directly on the target. *California*, *Tennessee*, and *West Virginia* received two Mk 34 main battery directors with the Mk 8 radar as part of their modernizations. *Maryland* received a similar fit at war's end, but *Colorado* ended the war with the Mk 3 radar.

USN Battleship Radar

The first radar fitted aboard a USN battleship was the experimental CXAM air-search radar which had a large mattress antenna mounted on the forward cage mast. This set had a theoretical maximum detection range of 16 nm against large surface targets and 70 nm against a large aircraft at 10,000 feet. In 1942, this was replaced by the SC radar. This set unsuccessfully tried to combine the CXAM's electronics with a smaller antenna. The improved SC-1 was more successful since its greater power translated into almost twice the range compared to the SC. The SC/SC-1 was replaced by the much more powerful SK air-search radar in all surviving older battleships by 1943. This could detect a large target at up to 100 nm flying at 10,000 feet.

The mainstay surface search radar was the SG. This was the first microwave radar to incorporate a plan position display which displayed a map of the search area which made interpretation much easier. Battleships first received this radar in early 1942, and the improved SG-1 entered service in May 1943. The modernized Big Five received two

This aerial shot of *Tennessee* dates from the 1920s. The ship's early fire-control systems are evident in this view. The two fighting tops on the cage masts contained the directors and spaces for spotters. The aft fighting top is engulfed in smoke which made it unbearable for crewmen working there. The rangefinders for the secondary battery are located on top of the superstructure and on top of Turret Number 3. Note also the concentration dial and deflection markings on Turrets Numbers 2 and 3 to allow other ships in the formation to calculate what *Tennessee*'s fire-control solution was.



SG radars, one each on the two pole masts. Optimal range was 22 nm against a battleship-sized target.

USN Battleship Tactics

The excellence of American radar-controlled gunnery was demonstrated at the battle of Surigao Strait on the night of October 24–25, 1944. This engagement was part of the battle of Leyte Gulf and featured a Japanese force of two Fuso-class battleships armed with 14-inch guns, a heavy cruiser, and four destroyers attempting to fight its way up the strait against a much larger USN force lying in wait. The American force included six battleships (*Pennsylvania*, *Mississippi*, *Tennessee*, *California*, *Maryland*, and *West Virginia),* eight cruisers, and 28 destroyers. The six old battleships were a mixed lot with the three most modern ships (*Tennessee*, *California*, and *West Virginia)* carrying the fully modern Mk 8 fire-control radar and the other three the much less capable Mk 3 radar.

With the advantage of knowing the Japanese were coming and the expectation of being able to track them on radar as they advanced up the strait, the USN commander made his dispositions with the battleships athwart the strait in a position to cross the "T" of the Japanese. The cruisers were placed on the flanks to defeat Japanese destroyer attacks and to participate in the attack on the main Japanese force. Because the USN battleships had the primary mission of supporting the landings on Leyte, they carried a reduced load of AP shells. With this in mind, the battleships were ordered to fire at 26,000 yards, rather than the maximum detected range, to make their fire more effective.

The actual battle, which was the last battleship duel in history, was anticlimactic. By the time the Japanese were picked up by the radars of the American battleships at the head of the strait, only the battleship *Yamashiro*, the heavy cruiser *Mogami*, and a destroyer remained. The other ships had been sunk or disabled by radar-guided torpedo attacks by USN destroyers.

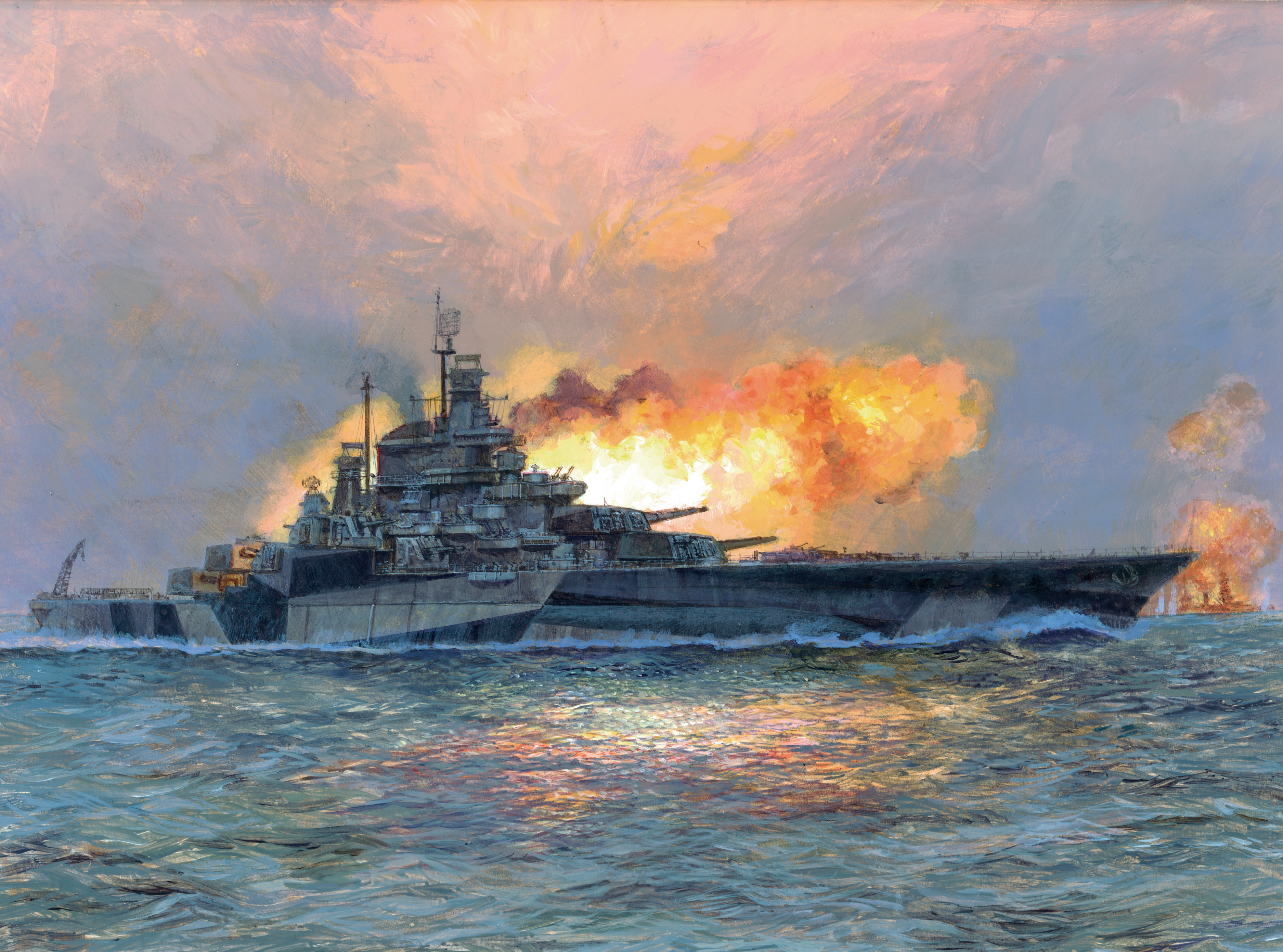
The American battleships gained radar contact at 0300 hours on 25 October at 43,900 yards. This was converted into a target track on the main battery Mk 8 radars at 39,000 yards. At 0355 hours, the battleships opened fire with *West Virginia* firing first at 22,800 yards. *Tennessee* opened fire at 20,500 yards range. Because they had the most modern radar fire control of the six battleships present, *Tennessee*, *California*, and *West Virginia* took the most shots; *West Virginia* fired 93 16-inch rounds in just under ten minutes; *Tennessee* and *California* fired 69 and 63 14-inch shells, respectively.

West Virginia was the most effective ship in the battle. All her salvoes were seen to straddle the target (*Yamashiro*) and probable hits were observed on salvoes 1, 2, and 6.

A

CALIFORNIA AT SURIGAO STRAIT

This scene shows *California* during the early hours of October 25, 1944 at the battle of Surigao Strait. The ship is in the process of firing a 14-inch salvo at IJN battleship *Yamashiro* in the last battleship duel in history. Using her modern fire-control systems, *California* was able to fire 63 shells at the Japanese ship, scoring several probable hits. The ship is in its late-war configuration following her dramatic modernization. The original cage masts and small stacks are gone, replaced by a new superstructure with a single trunked stack and an aft fire-control tower. Barely evident in this night view is the ship's new electronics and antiaircraft suites. A single catapult remains on the fantail. The ship is in the Ms 32/16D dazzle camouflage scheme.



This is *West Virginia* seen from *Pennsylvania* in action early on October 25, 1944 at the battle of Surigao Strait. Equipped with the most modern USN fire-control radar available, the battleship provided one of the most impressive displays of battleship gunnery during the entire war, hitting the Japanese battleship *Yamashiro* with her first salvo.

Maryland had the Mk 3 radar, and was unable to find a target until the range closed to 22,000 yards. At this point, a target suddenly appeared on radar because it had turned broadside thus presenting a much larger surface for a radar return. *Maryland* was able to fire 48 rounds in six minutes and appeared to hit on the second and fourth salvoes.

Mississippi also had a Mk 3 radar so was late to open fire. Though she was able to detect the Japanese at 43,000 yards with her radar, her fire-control radar could not break out the types of the targets. Ranging on *West Virginia*'s splashes, *Mississippi* fired a single salvo at *Yamashiro* at 19,000 yards. *Pennsylvania* did not fire at all due to a combination of problems with her Mk 3 radar and poor practices by her gunnery control personnel. In reply, *Yamashiro* was able to get off several 14-inch salvoes from her two forward turrets at the flanking cruisers, but was unable to hit a target. None of the USN battleships were taken under fire during the battle.

The gunnery part of the battle lasted only 14 minutes. *Yamashiro* was hit by an unknown number of 14- and 16-inch shells, in addition to many 6- and 8-inch shells from the cruisers. After being hit by two destroyer-launched torpedoes, she sank at 0419 hours. *Mogami* was damaged further, but refused to sink and staggered back down the strait to be sunk by aircraft later in the day. The sole destroyer escaped. The last battleship engagement in history was a resounding victory for the USN and showed the full capabilities of the most modern of the old battleships.

THE BATTLESHIP CLASSES

Tennessee Class

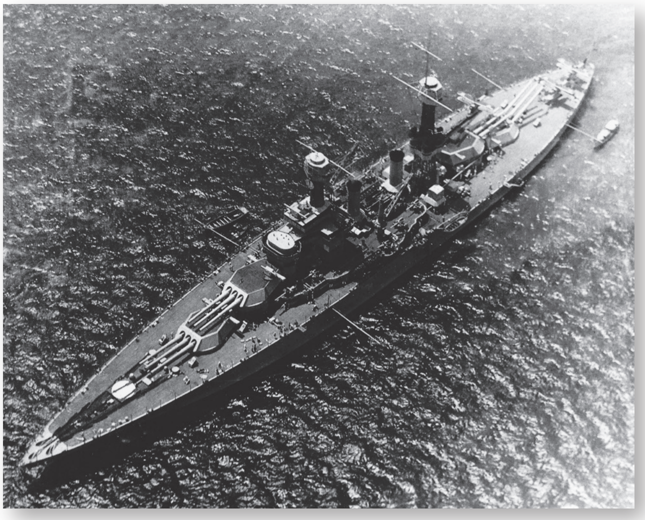
Design and Construction

For the 1915 battleship building program, Congress approved the normal two ships. These were authorized in March 1915 and contracts placed for the two ships in December. In February, the ships' new underwater protection scheme was approved and added to the design while a decision was also being made whether to adopt turbo-electric propulsion for the new class. This meant the design was not completed until March 1916. Construction began that October on *California* and work on the second ship was begun in May 1917.

Tennessee Class Construction

Ship	Built at	Laid down	Launched	Commissioned
Tennessee	New York Navy Yard	14/5/17	30/4/19	3/6/20
California	Mare Island Navy Yard	25/10/16	20/11/19	10/8/21

As completed, no provisions for operating aircraft were provided. In 1924, the first catapults were fitted on the fantail and on top of the Number 3 14-inch turret. Space was adequate for three aircraft. These were considered as essential equipment since the aircraft provided gunnery spotting which made accurate long-range fire possible.



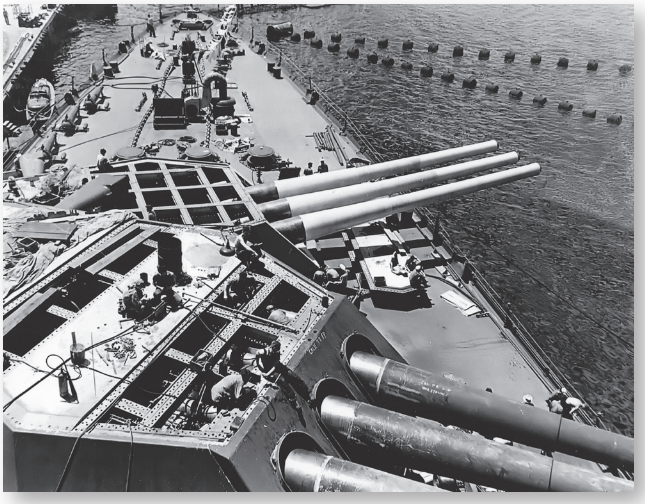
A March 1930 aerial oblique shot of *Tennessee* showing the arrangement of the main, secondary, and antiaircraft batteries. Note the placement of the two catapults with one on the fantail and the other on Turret Number 3.

Protection

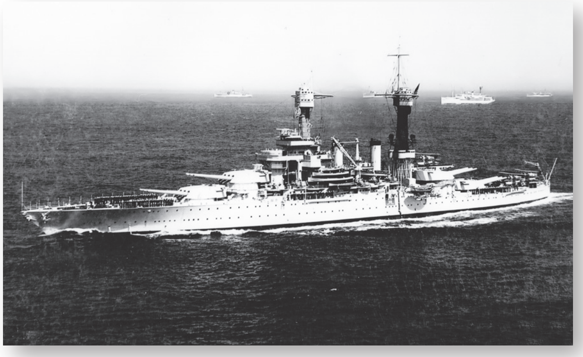
The protection of the Tennessee class can be traced back to the Nevada class in regards to the main belt and other armor arrangements. The main armor belt was a total of 17 feet wide; maximum thickness was 13.5 inches (for a width of 10.5 feet) which tapered down to 8 inches on the lower edge. Half of the main belt was below the waterline and it was backed by concrete, not wood. The armored bulkheads and both ends of the belt had a maximum thickness of 13.5 inches. The turret barbettes received between 14 and 16 inches of armor, the conning tower 16 inches and the turret faces 18 inches. The sides and rear of the turrets were protected by 8 inches of armor and the roof 5 inches.

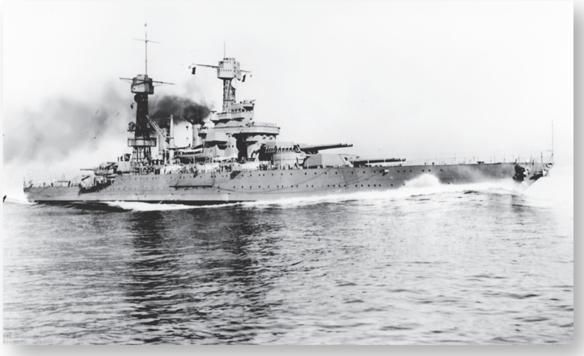
The USN recognized that horizontal protection was a weakness of its battleship designs and kept making incremental improvements to address this. The main armored deck remained at 3.5 inches arranged in two layers, and the lower armored deck added another 2 inches over the machinery spaces and 1.5 inches elsewhere. The main armored deck was designed to explode armor-piercing shells, while the lower armored deck, also called the splinter deck, was designed to prevent shell fragments from entering the ship's vitals.

An even greater requirement was the need to give the ship underwater protection against mines and torpedoes. Early USN dreadnoughts had no dedicated underwater protection which was clearly a critical weakness. The New Mexico class tried to address this weakness with a 3-inch torpedo bulkhead 9.5 feet inboard from the outer hull which was fitted with a width of almost 12 feet. This system was designed to withstand an explosion of 300 pounds of TNT. The Tennessee class went a step further. A series of longitudinal splinter bulkheads was placed between the double bottom to the lower armored (splinter) deck. The spaces between these bulkheads were designed to absorb the force of a blast against the side of the ship by either being void or filled with liquid. Eventually, it was decided that the most effective arrangement was to have the outer compartment left as a void, the next three filled with a liquid (either fuel oil or water), and the innermost compartment was void to take the compression of the expanding liquid.



This view shows crewmen rebuilding *California*'s forward two 14-inch turrets in August 1942. The strength of the turret's armor is evident – the face of the turret was protected by 18 inches of armor, the side by 8 inches, and the roof by 5 inches of armor.





LEFT
This view of *Tennessee* is from May 1934 and shows the clean form of the ship's hull from the lack of casemate guns. The secondary battery rangefinders are located on top of the superstructure and of Turret Number 2.

RIGHT
California on full-power trials in 1921. The ship was designed without casemate hull guns and kept the prominent cage mast and triple 14-inch turrets from the preceding New Mexico class battleships.

The maximum depth of this system was 17 feet 3 inches from the outer hull. The system was designed to withstand the blast of 400 pounds of TNT. This concept was well in advance of its time and gave the USN the best underwater protection of any dreadnought designed before World War II. The system was so successful that all future USN battleships used it as the basis for their underwater protection systems.

Propulsion

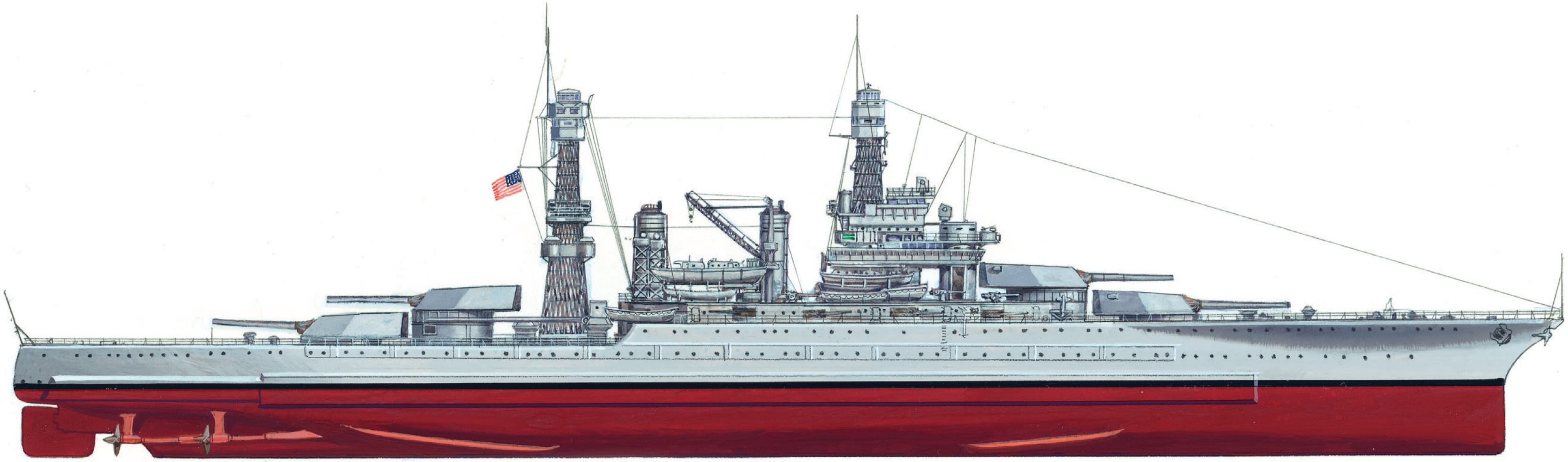
One of the three ships of the preceding New Mexico class, *New Mexico*, was fitted with a turbo-electric power plant to test its suitability for use on battleships. If successful, turbo-electric drive offered some key advantages in the form of greater efficiency which meant a greater steaming radius and the ability to provide much greater internal subdivision in the machinery spaces because of the reduced size of the turbo-electric drive compared to traditional steam turbines. Trials on *New Mexico* were successful, and they were designed into the Tennessee class. The new ships had eight boilers powering two electric generators which produced power for four electric motors. The steam turbines were coupled directly to alternators. The current produced was fed to motors which were coupled to the propellers. This provided 26,800 shp on four shafts which was adequate for the design speed of 21 knots. The boilers were placed in individual compartments inboard of the anti-torpedo system forming another protective layer. The two turbo-generators were on the centerline and were not located near one another. The dispersion of the generators was evident in the layout of the two stacks.

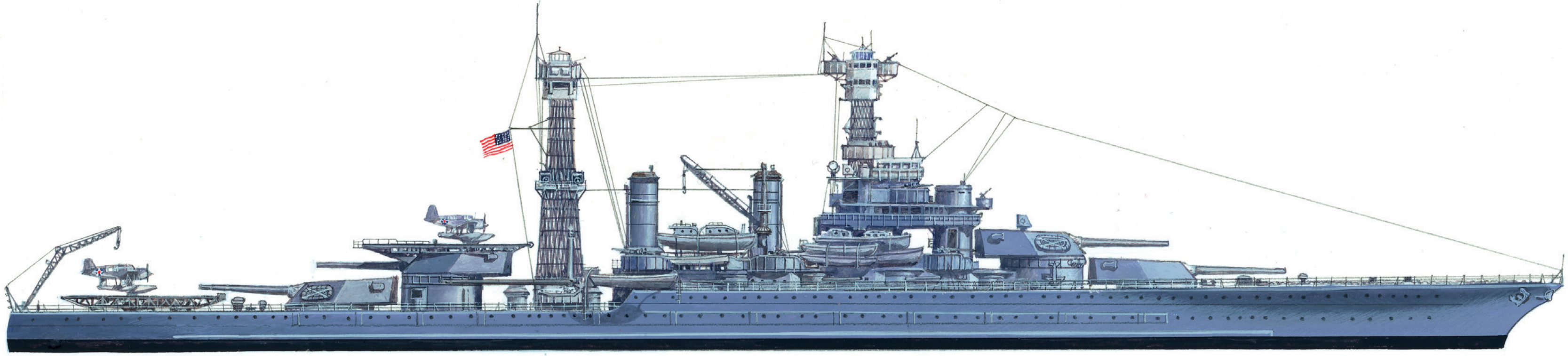
The entire system had several advantages. Because the shafts were powered by electric motors, there was no requirement for direct mechanical linkages between the turbines and the shaft. This meant that internal subdivision could be improved. Turbo-electric drive meant that no complicated and expensive gearing was required. A high astern speed could be achieved simply by reversing the motor. The system also gave a higher degree of redundancy to battle

B

THE TENNESSEE CLASS

The top profile depicts *Tennessee* as she appeared in 1922 just after being completed. The ship gives a clean and balanced appearance overall with her symmetrical main battery layout, two prominent cage masts, and clipper bow. Note the absence of any hull casemates for the secondary battery and the armored conning tower abaft Turret Number 2. The lower profile depicts *California* in her early-war configuration at Pearl Harbor in December 1941. The ship is in the standard USN pre-war camouflage called Ms (Measure) 1. No major modifications were conducted after her commissioning, and changes like an enhanced antiaircraft battery are not discernible, but the two catapults (one on the fantail and the other on the roof of Turret Number 3) are clearly seen.





damage since power to the electric motors could be cross-connected. However, there were also disadvantages. The system was slightly less efficient than geared turbines, but the main drawback was a 40 percent lower power-to-weight ratio. This was a critical factor if weight restrictions were in play, and in fact led to the decision to return to steam turbines when the USN began designing battleships in the 1930s under a 35,000-ton limit.

Armament

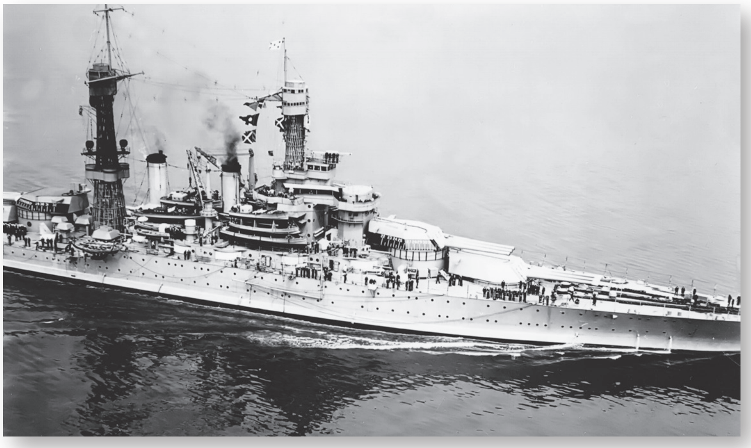
The standard USN battleship gun of the period was the 14-inch which had been fitted on every design since the Nevada class. The Tennessee class kept this proven gun and used the same arrangement and type of turret as on the New Mexico class. A total of 12 14-inch guns were fitted in four triple turrets placed in pairs fore and aft. The Tennessee class was the last USN battleship to use 14-inch guns. The secondary battery was originally planned at 22 5-inch/51 single guns, almost all in casemates. However, before completion, the hull casemates were eliminated bringing the total to 14. Antiaircraft protection was provided in the form of four 3-inch guns. Two 21-inch submerged torpedo tubes were also fitted.

By 1922, the antiaircraft suite was increased to eight 3-inch guns at the expense of two of the 5-inch/51 secondary guns. The submerged torpedo tubes were removed (in 1934 for *Tennessee* and 1937 for *California*) since it was recognized they were useless in any kind of realistic battle scenario. In 1929–30, the eight 3-inch guns were replaced with the 5-inch/25 gun. In 1935–36, .50-caliber machine guns were placed on the foretops – two fore and four aft – and two more were added adjacent to the foremast. In December 1940, four 3-inch/50 guns were added in tubs below the bridge wings and abreast the cranes.

Service Modifications

Both ships were present at Pearl Harbor and both were damaged to varying degrees. Eventually both were rebuilt from the main deck up. Since *California* was severely damaged at Pearl Harbor, she was the first of the sisters to begin reconstruction. She was raised and sent to the West Coast for a rebuild which began in June 1942. The scope of the work was such that she did not re-enter service until January 1944. The most dramatic difference was the replacement of the former superstructure with an entirely new one based on the South Dakota class (not the cancelled dreadnought class from 1922, but the new class of fast battleships). A single stack was trunked into the new superstructure and a small aft superstructure was built to support the second main battery fire-control director. The fore and aft towers with main battery directors became the standard USN signature for its heavy ships.

The armament was almost entirely renewed. The main battery remained, but was modified to automatic control and the new Mk 34 director fitted on the two new towers. The old secondary and



California in 1925 showing the layout of her secondary battery (six 5-inch/51 guns per beam). The secondary battery remained constant, but the antiaircraft battery was upgraded to 5-inch/25 guns in 1929–30.

long-range antiaircraft batteries were removed. In their place, a battery of 16 dual-purpose 5-inch/38 guns was fitted. This came in the form of eight twin turrets, four per beam, with the inner mounts superfiring over the outer mounts. Fire control for the guns was provided by four Mk 37 directors. These were placed fore and aft and one on each beam between the middle 5-inch/38 mounts.

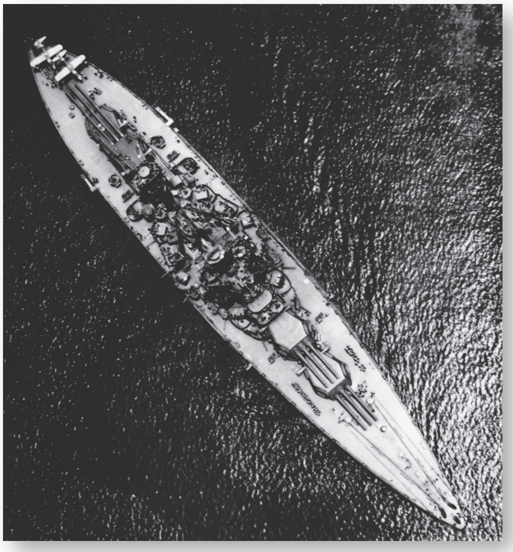
Another dramatic improvement was in the scale and effectiveness of the ships' light antiaircraft battery. In addition to the large dual-purpose 5-inch/38 battery, intermediate and light antiaircraft was greatly enhanced. The effective 40mm gun was fitted in the form of 14 quad mounts and 52 single 20mm guns were added.

Protection was also enhanced. The most important addition was a torpedo blister which increased overall beam to 114 feet making the ship too wide to use the Panama Canal.

In addition to the blister, more internal longitudinal bulkheads were added to increase underwater subdivision. Horizontal protection was increased by 2 inches of armor (3 inches over the magazines) for a total of 7 inches (8 over the magazines). The roofs of the turrets also received additional armor bringing them up to 7 inches.

To compensate for all this new top weight, the original conning tower was eliminated and replaced by a much lighter one based on Brooklyn class light cruisers. The catapult in Turret Number 3 was also deleted, but the catapult on the fantail was retained.

After this transformation, full load displacement increased to almost 41,000 tons. New boilers increased power to 32,500 shp, but this was negated by the increased displacement. Post-modernization speed was a maximum of 20.5 knots. The ship's crew grew to 2,375 men, more than double the original crew when the ship was launched.

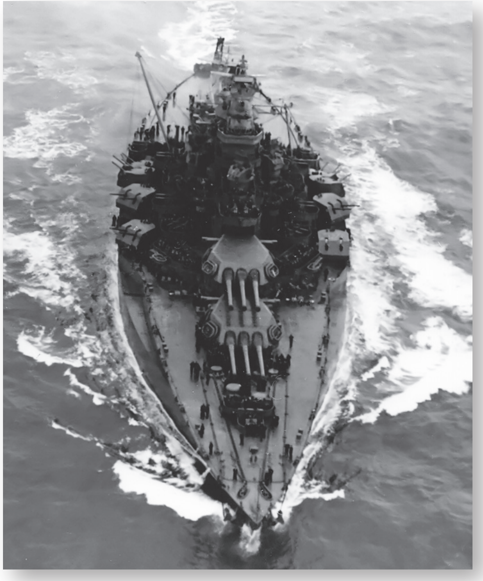


This aerial vertical view of *Tennessee* from June 1942 shows all the early-war modifications to the ship. The aft cage mast has been removed and replaced with a small superstructure. The forward cage mast has the SC radar on top. All the 5-inch/25 guns have been provided with shields, and 20mm single mounts have begun to proliferate.

Wartime Modifications to Tennessee Class Battleships

	5-inch/51	5-inch/25	5-inch/38	40mm	1.1-inch/3-inch	20mm
Tennessee (12/41)	12	8	0	0	4	0
Tennessee (2/42)	10	8	0	0	4	14
Tennessee (6/42)	10	8	0	0	6	14
Tennessee (5/43)	0	0	16	40	0	43
California (12/41)	12	8	0	0	4	0
California (1/44)	0	0	16	56	0	52

Tennessee ended up in the same basic configuration as *California*, but since she was not heavily damaged at Pearl Harbor, her modernization did not take as long. After Pearl Harbor, the uncertainty of the Japanese threat meant it was crucial to get her back in service as soon as possible. Repairs took only several weeks, and she rejoined the Pacific Fleet's battle line in



This aerial bow view of *Tennessee* in December 1943 shows the battleship after reconstruction. The new superstructure is evident, as are the eight twin 5-inch/38 twin mounts. Three of the Mk 37 directors for the 5-inch/38s are visible forward and on both sides of the superstructure. The Mk 34 director with the Mk 8 radar for the main battery is visible on top of the superstructure.

February 1942. Before re-entering service, a minimum antiaircraft enhancement was quickly done with the quadruple 1.1-inch mounts replacing the 3-inch mounts and 14 single 20mm mounts added. All the 5-inch/25 guns were shielded. An SR radar was fitted on the forward cage mast and Mk 3 fire-control radars were added to the main battery directors. The after cage mast was removed and replaced by a small tower which altered the ship's appearance. In June 1942, two more quadruple 1.1-inch mounts were added on the quarterdeck.

In September 1942, the Japanese threat had subsided enough to take the ship out of service for modernization. This mirrored the work already underway on her sister ship. On *Tennessee*, ten quad 40mm mounts were fitted along with 43 single 20mm guns.

When re-commissioned, the ship had a radar suite of an SG radar on the foremast and a SC-2 on the mainmast. The Mk 34 main battery directors were fitted with Mk 8 fire-control radars and the Mk 37 secondary battery directors received the Mk 4 radar.

During the ship's late 1944 overhaul, the ship's radar fit was altered again to an SK on the foremast, an SP fighter direction radar on the mainmast, and the Mk 37 directors received the Mk 12/21 radar combination. The ship's complement grew to 2,240 men.

Wartime Service

Tennessee was completed in 1920 and by the next year she was homeported at San Pedro, California as part of the Pacific Fleet[1]. She spent her entire pre-war career in the Pacific. The battleship was scheduled to undergo a major yard period in 1939 but, as tensions in the Pacific increased, this was postponed. In 1940, she received a refit at Puget Sound Navy Yard, Bremerton, Washington, and then went to the Pacific Fleet's new main base at Pearl Harbor.

Tennessee was one of the eight battleships present at Pearl Harbor when the Japanese attacked on December 7, 1941. The battleship was moored inboard of *West Virginia* on Battleship Row making her invulnerable to torpedo attack. The Japanese had planned for this and, furthermore, they employed 49 aircraft carrying 1,760-pound armor-piercing bombs. Dropped from altitude, these had the potential to penetrate battleship armor, as was shown that morning when *Arizona*'s magazine exploded resulting in the total loss of the ship. Of the 49 bombs dropped on Battleship Row, ten hit a target. Two of these struck *Tennessee*. The first hit the center gun of Turret Number 2 and the second pierced the roof armor of Turret Number 3 but broke apart without detonating. Additional damage was created from debris and burning oil from the destroyed *Arizona* which was moored only 75 feet aft. Many of *Tennessee*'s hull plates buckled due to the heat. All told, damage was light and casualties were only five killed and 21 wounded. The sunken *West Virginia* wedged *Tennessee* against the mooring station, but the ship was freed and underway by December 20. The ship departed for repairs on the West Coast which were completed by February 1942.

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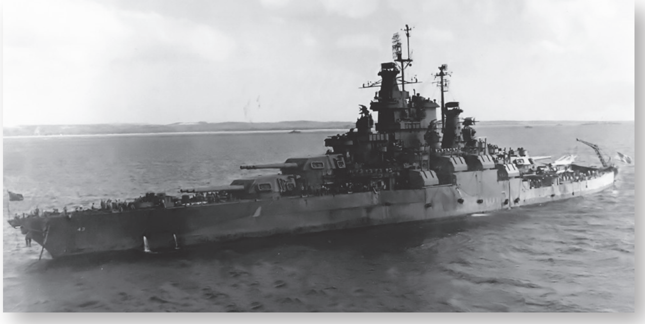
[1] From 1907 until December 6, 1922, the USN's primary Pacific presence was known as the US Pacific Fleet. From December 1922 until 1 April 1931, the USN's battleships in the Pacific were assigned to the Battle Fleet and from 1931 until 1 February 1941 to the Battle Force, United States Fleet. From February 1941 until present, all elements in the Pacific were combined into the US Pacific Fleet.

Following repairs, the ship joined Task Force 1 in San Francisco which was charged with defense of the West Coast. The fear of a Japanese attack on the West Coast dissipated after the battle of Midway in June 1942. *Tennessee* was released for reconstruction and arrived in Puget Sound on August 27, 1942. The work was not completed until May 1943 and she rejoined the Pacific Fleet just as the American offensive across the Pacific was getting into gear.



Tennessee anchored off Saipan on February 15, 1945. The ship is now wearing the Ms 21 dark blue scheme. The view provides a good perspective of the superstructure and the ship's updated electronics fit which includes the SM fighter control radar on the aft pole mast.

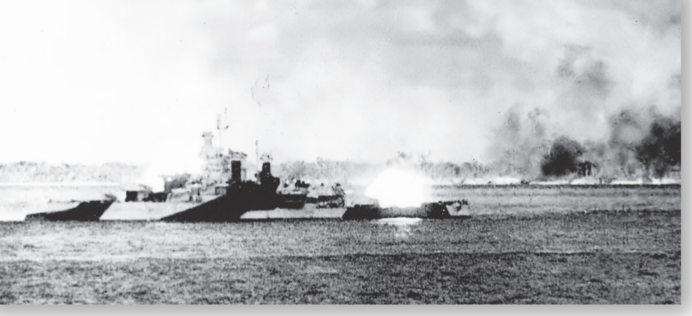
Tennessee's first combat deployment of the war was to the North Pacific as part of the force to re-take the Aleutian Islands of Kiska and Attu. On 1 August, she bombarded Kiska with 60 rounds of 14-inch shells and followed up with another bombardment on 15 August when US Army troops landed. This was all for nothing since the Japanese garrison had been evacuated on the night of July 27–28.

Next up for *Tennessee* was the invasion of the Gilberts in the Central Pacific. She was one of three battleships assigned to bombard Betio Island where the main Japanese garrison was located. On November 23, *Tennessee*'s secondary battery helped destroy Japanese submarine *I-35* which had broached near the island following a depth charge attack by USN destroyers. *Tennessee* returned to action on January 31–February 2, 1944 when she bombarded Majuro, Roi, Kwajalein, and Namur in the Marshalls. In the operation to take Eniwetok Atoll, *Tennessee* closed to point-blank range on February 17 off Engebi Island which allowed her 40mm guns to join the bombardment. On February 22, she bombarded Parry Island.

On March 20, she was one of four battleships that bombarded Kavieng in New Ireland. In this action, she engaged in an inconclusive duel with Japanese shore batteries. In three hours, *Tennessee* fired 252 14-inch and 1,892 5-inch rounds. After returning to Pearl Harbor, she deployed again as part of the largest USN operation to date, the invasion of the Marianas.

Tennessee bombarded Saipan and engaged in a duel with shore batteries on nearby Tinian on June 14, 1944. She returned off Saipan on June 15 for the landings. The battleship was hit by three 4.7-inch Japanese shells from a shore battery on nearby Tinian. One knocked out a 5-inch mount and caused a fire that was quickly extinguished; a second hit the side belt and caused no real damage; the third hit aft on the main deck and caused a fire in the space below. Eight crewmen were killed and 25 wounded. She retired briefly to Eniwetok for repairs before returning for the invasion of Guam. *Tennessee* shelled Guam from July 20–21, and then pounded Tinian from July 23–31. *Tennessee* returned to Guam on August 2 to support operations ashore until the island was secured a week later. On August 23, she collided with *California* which resulted in damage to both ships. Her captain was relieved as a result of this incident.

The starboard-side view of the still-moored *Tennessee* is from December 7, 1941. The ship suffered only light damage and was able to leave Pearl Harbor on December 20 for repairs and light modernization on the West Coast.



LEFT
Tennessee engaging Japanese positions on Peleliu. The ship is firing two of its 14-inch turrets at point-blank range. The ship is wearing the Ms 32/1D dazzle camouflage scheme.

RIGHT
Tennessee burning after being struck by a kamikaze off Okinawa on April 12, 1945. Five kamikazes attacked the battleship; the first four were destroyed by 5-inch fire, but the last suicide aircraft survived 40mm and 20mm fire to crash onto a 40mm mount before sliding down to Turret Number 3 where its bomb exploded. The other ship is the destroyer *Zellars* which has also been hit and is burning.

In September, *Tennessee* covered the invasion of the Palau Islands. In October, she participated in the invasion of Leyte. From October 19, she bombarded Leyte, and then took part in the action in Surigao Strait on October 25 as has already been detailed.

Following this action, *Tennessee* returned to the United States for refit. She returned to action on February 16, 1945 in time for the invasion of Iwo Jima and she remained on station there until March 7 firing a total of 1,370 14-inch shells.

Tennessee's participation in the Okinawa campaign lasted from March 26 until May 1 and she came under intense kamikaze attack on April 12. After several aircraft were shot down, a D3A "Val" dive-bomber hit the starboard side of the superstructure and proceeded to slide aft. Before the plane slid into the sea, its bomb detonated. Casualties were heavy in the exposed antiaircraft crews with 22 killed and 107 wounded. A fire was started, but little serious damage was inflicted. *Tennessee* remained on station until May 1 when she departed for repairs at Ulithi in the Caroline Islands. By June 9 she was back off Okinawa. Her final action was covering minesweeping operations in the East China Sea. For her Pacific War service, *Tennessee* earned ten Battle Stars and a Unit Commendation.

On December 7, 1945, *Tennessee* arrived in Philadelphia to join the reserve fleet. Mothballed in 1946, she was decommissioned on February 14, 1947 and never brought back into service. On March 1, 1959, *Tennessee* was struck from the Naval Register and she was sold for scrap in July and scrapped in Baltimore.

California was also present at Pearl Harbor when the Japanese struck in December 1941. Unlike *Tennessee*, *California* was moored by herself, so was vulnerable to torpedo damage. The first torpedo struck on the ship's port beam below the armor belt. A second torpedo also struck on the port side, again below the armor belt, between the bridge and Turret Number 2. Neither of these hits completely defeated the anti-torpedo defenses, but they did create a port list. Prompt counterflooding saved the ship from capsizing. The first hit resulted in all power being lost. In the second attack wave, between one and three Val dive-bombers selected *California* as their target. At 0845 hours, a 550-pound bomb hit the starboard upper deck next to a 5-inch mount and penetrated to the second deck where it caused many casualties and created a fire.

Power was restored at 0855 hours, allowing the fires to be fought successfully. Burning oil from *Oklahoma* engulfed the ship's stern and at 1002 hours the crew was ordered to abandon ship, but this was rescinded at 1015 hours after the flames subsided. The ship had material condition

The damage to *Tennessee* was not enough to keep her out of action. Here she is shown on fire aft after having been struck by a kamikaze.

issues which prevented full watertight integrity from being achieved. Progressive flooding from the two torpedo hits continued unchecked, and by December 10 the ship had settled on the bottom of the harbor with her main deck still above water. The attack accounted for 98 dead and 61 wounded.

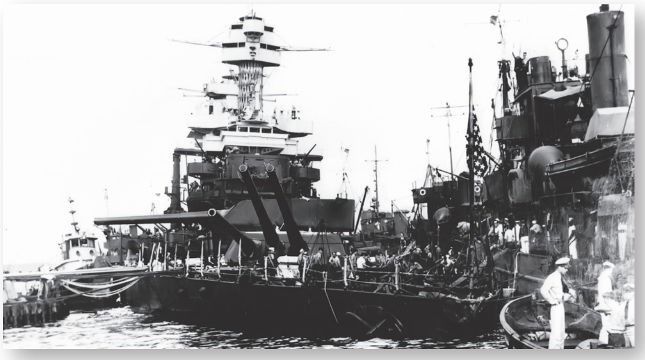
In preparation for salvage, the ship was stripped of much topside gear. The torpedo damage was patched by means of a cofferdam and all other hull openings secured. Finally, the ship was pumped dry and refloated on March 24, 1942. After more extensive work in drydock to make the hull watertight, the ship departed Pearl Harbor under her own power for Puget Sound Navy Yard for modernization which took until January 1944.

California's war began in earnest in June 1944 when she provided gunfire support for the landings on Saipan. She later supported the landings on Guam and Tinian in July and August. The collision on August 23 with *Tennessee* was more severe for *California* but repairs were done in a remarkably quick 17 days in the drydock located at Espiritu Santo in the New Hebrides. The battleship was present at Leyte from October 17 to November 20 during which time she participated in the battle of Surigao Strait.

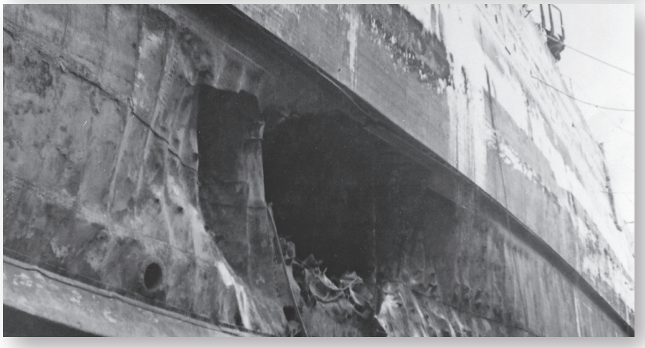
California was one of six battleships which took part in the landings on Luzon in January 1945. The entry of the invasion force into Lingayen Gulf prompted a major Japanese air reaction. A kamikaze struck *California* on January 6. Damage was severe – the aft main battery director was knocked out and the blast and fires killed 44 and wounded 155. The ship remained in action until 23 January when she departed for repairs at Puget Sound.

Following repairs, *California* returned to the gun line off Okinawa on June 15 and remained on station until the island was declared secure on June 21. This was followed by a sweep into the East China Sea on July 22. For her service, she earned seven Battle Stars.

On December 7, 1945, she arrived in Philadelphia to join the reserve fleet. The battleship was placed in reserve on August 7, 1946 and taken out of commission on February 14, 1947. On February 24, 1959, she was struck from the Navy Register. *California* was sold for scrap in July and scrapped in Baltimore.



TOP
California ended up on the bottom of Pearl Harbor following progressive flooding from two torpedo hits. The ship was raised in March 1942 and later sent to Puget Sound for reconstruction.



BOTTOM
California in drydock showing her amidships torpedo damage. The ship was out of service from December 1941 until January 1944 while she underwent reconstruction.

Tennessee Class Specifications (as built)	
Displacement	32,300 tons standard; 33,190 tons full load
Dimensions	Length 624 ft overall; Beam 97 ft 5 in.; Draft 30 ft 2 in.
Speed	21 kts
Range	8,000m at 10 kts
Crew	1,083

LEFT
This action shot of a Japanese kamikaze headed for *California* was taken on January 6, 1945 in the Lingayen Gulf. The photo was taken from the battleship *Pennsylvania*. Note the heavy volume of fire which would appear impenetrable for a low-flying aircraft.

RIGHT
Despite the volume of defensive fire directed against the approaching kamikaze, *California*, seen here astern of the battleship *Pennsylvania*, has just been struck. The explosion looks serious, but on this occasion damage was light, however, personnel casualties were heavy with almost 200 killed and wounded.

Colorado Class

Design and Construction

The battleship design for the year 1917 was a natural development of the preceding year's class. The new class, named after the second ship in the class to be commissioned, but the first ship in the class in the USN's numerical sequence for designating battleships, took the same dimensions, propulsion systems, and protection scheme as on *Tennessee* and *California* and substituted the new 16-inch/45 gun for the standard 14-inch/50. The decision to up-gun the new class was made in August 1916, and plans were quickly drawn up for bids in October.

The move to the 16-inch gun had been contemplated for some time and work was already advanced in the USN's first gun of this caliber. Intelligence that the Japanese were planning to equip the Nagato class (two ships, one laid down in 1917 and the second in 1918) with 16-inch guns forced the decision to move to the 16-inch gun on the Colorado class. Originally, four ships of the class were authorized in August 1916 with three ordered in December 1916 and the last in January 1917.

Colorado Class Construction

Ship	Built at	Laid down	Launched	Commissioned
Colorado	Camden, NJ	29/5 /19	22/3 /21	30/8 /23
Maryland	Newport News, VA	24/4 /17	20/3 /20	21/7 /21
Washington	Camden, NJ	30/6 /19	1/9 /21	Never
West Virginia	Newport News, VA	12/4 /20	19/11/21	1 /12/23

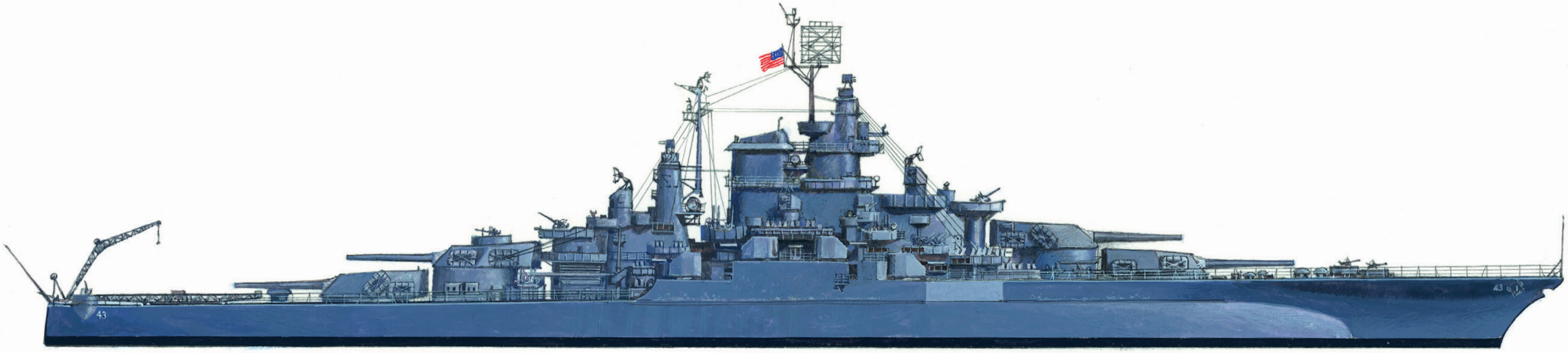
As the class was being completed, the Washington Naval Treaty, signed in February 1922, came into effect. Only *Maryland* was already in service, and the other ships appeared as if they would never be completed. The Japanese

C

TENNESSEE IN 1945 AND *WEST VIRGINIA* IN 1924

The top profile depicts *Tennessee* in 1945 in her final configuration. The ship is in the late-war dark blue Ms 21 camouflage scheme which was preferred against air threats. *Tennessee* is almost unrecognizable from her commissioning appearance. Only her original main battery remains unaltered. The secondary battery and original antiaircraft batteries have been replaced with dual-purpose 5-inch/38 mounts and a host of 40mm quad and 20mm single mounts. The prominent cage masts are gone and have been replaced with compact fire-control towers with a Mk 34 director on top. Three of the Mk 37 fire-control directors for the 5-inch guns are also evident, as is the SK radar on the forward pole mast.

The bottom profile features *West Virginia* in 1924 shortly after entering service. The ship looks like the Tennessee class with the exception of the main battery which consists of four twin 16-inch gun turrets. An early catapult is evident on the fantail which was later augmented by a second catapult on the roof of Turret Number 3.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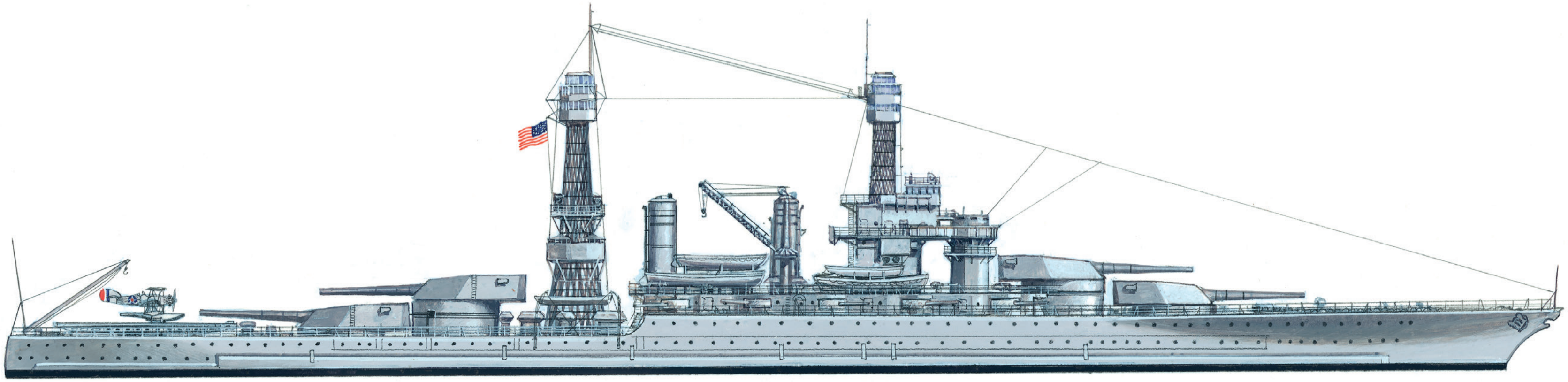


OPPOSITE
This port bow shot of *West Virginia* on December 18, 1923 shows the battleship just after her commissioning. The lack of hull casemates gives the ship a clean appearance, and the clipper bow results in a modern look. As indicated, the protection of the USN's first 16-inch battleship was identical to that of the preceding Tennessee class. By USN standards, the ship was under-armored since the thickness of the main belt did not equal the caliber of the main battery guns. The total weight of armor in the class was 12,353 tons which equated to 35.8 percent of the ship's normal displacement.

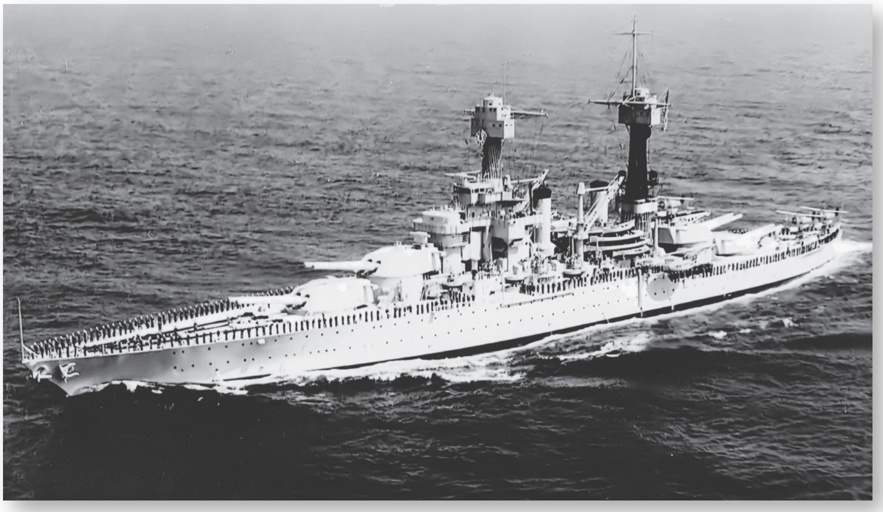
fought hard to keep the new 16-inch battleship *Mutsu* (sister ship of *Nagato*), and in compensation the USN was allowed to complete *Colorado* and *West Virginia*. The last ship of the class, *Washington*, was never finished. The ship was launched in September 1921 and then cancelled as a result of treaty obligations when she was 75.9 percent complete. The ship had belt armor and barbettes fitted, but no boilers or machinery. The unfinished hull was put to use as an ordnance trials platform in November 1924. It was then sunk off the coast of Virginia by 14-inch shells from the battleship *Texas*.

Maryland was the first USN battleship to get a catapult when a single device was fitted on the fantail in 1922. After the success of this experimental installation, spotting aircraft became an integral part of every battleship's capabilities. Battleship aircraft handling facilities were standardized with two catapults. One was fitted on the fantail and was serviced by a crane fitted at the stern; the second was placed on top of Turret Number 3 and serviced by the two cranes fitted abreast the aft cage mast.

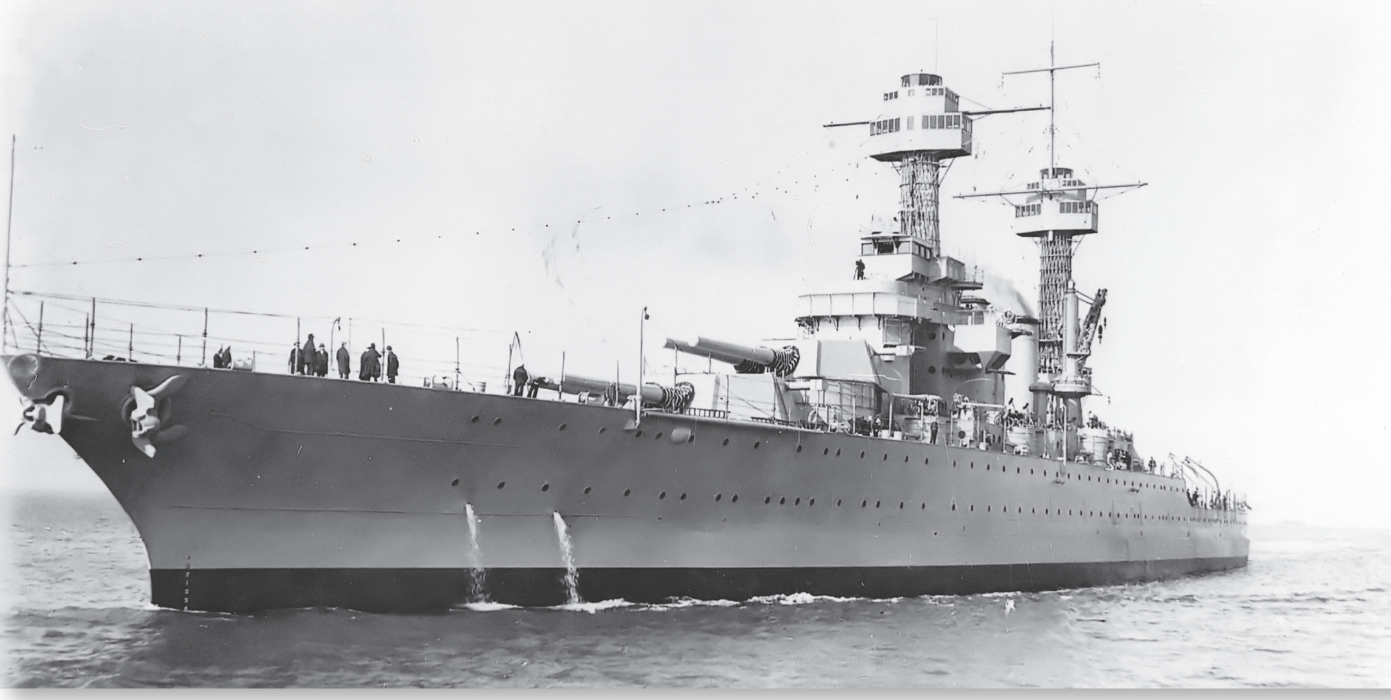
Armament

The Colorado class was the first USN battleship to carry 16-inch guns. In fact, every other USN battleship completed afterward carried a 16-inch gun, though later ships employed a 50-caliber weapon. The main battery of the Colorado class used the same four-turret layout of every other Standard-type battleship. Serious consideration was given to adding a fifth twin 16-inch turret aft, but this was ultimately rejected. Even with the number of main battery guns reduced from 12 to eight, the broadside of the Colorado class was virtually identical to that of the preceding Tennessee class. Eight 16-inch guns delivered a broadside of 17,920 pounds compared to the 18,000-pound broadside of a ship equipped with 12 14-inch guns. More importantly, and as already mentioned, the heavier 16-inch shell possessed greater penetrative powers against armored targets.

The secondary battery repeated the pattern of the Tennessee class modernization with 12 5-inch/51 single guns, almost all in casemates. None of these was mounted on the hull, which gave the ships a cleaner appearance. Antiaircraft protection was provided in the form of eight 3-inch guns. Two 21-inch submerged torpedo tubes were also fitted amidships when the ship was completed, but these were removed fairly early in the ships' careers (1928–29).



A classic aerial oblique view of *Colorado* in 1934. The crew is manning the rails in their Winter Blue uniforms. The ship gives a clean and balanced appearance with its symmetrical main battery and two prominent cage masts.

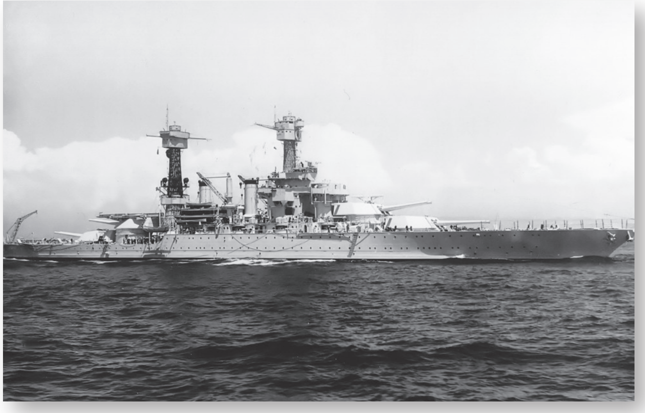


In 1928–29, the eight 3-inch guns were replaced with the 5-inch/25 gun. Immediately before the US entered the war, steps were taken to improve the ships' antiaircraft capabilities as a result of British experience in the war in Europe. It was planned to add four 1.1-inch quad mounts to each ship before the war, but only *Maryland* received these.

Service Modifications

The modernization of the three Colorado class ships took two very different paths. The most drastic modernization belonged to *West Virginia*, sunk at Pearl Harbor. After her salvage, she was sent to Puget Sound for an extensive rebuilding much like that done to *Tennessee* and *California*. *Maryland* was also at Pearl Harbor, but was only lightly damaged. She was quickly returned to service, and then never had the opportunity for a prolonged period of modernization. The same applied to *Colorado*, which began the war in Puget Sound and thus was not damaged, but also was never given an extensive modernization.

Colorado was undergoing refit at the start of the war. She emerged in February 1942 with bulges which increased buoyancy and added greater protection from torpedoes while increasing the beam to 108 feet. The antiaircraft suite increased with the addition of four 1.1-inch quad mounts and 14 single 20mm guns. The 5-inch/25 mounts received anti-splinter shields. The SC radar was added along with two Mk 3 fire-control radars. Later in 1942, the aft cage mast was cut down and 20mm guns placed on the remaining stump. By late 1942, the ship carried 22 20mm single guns.



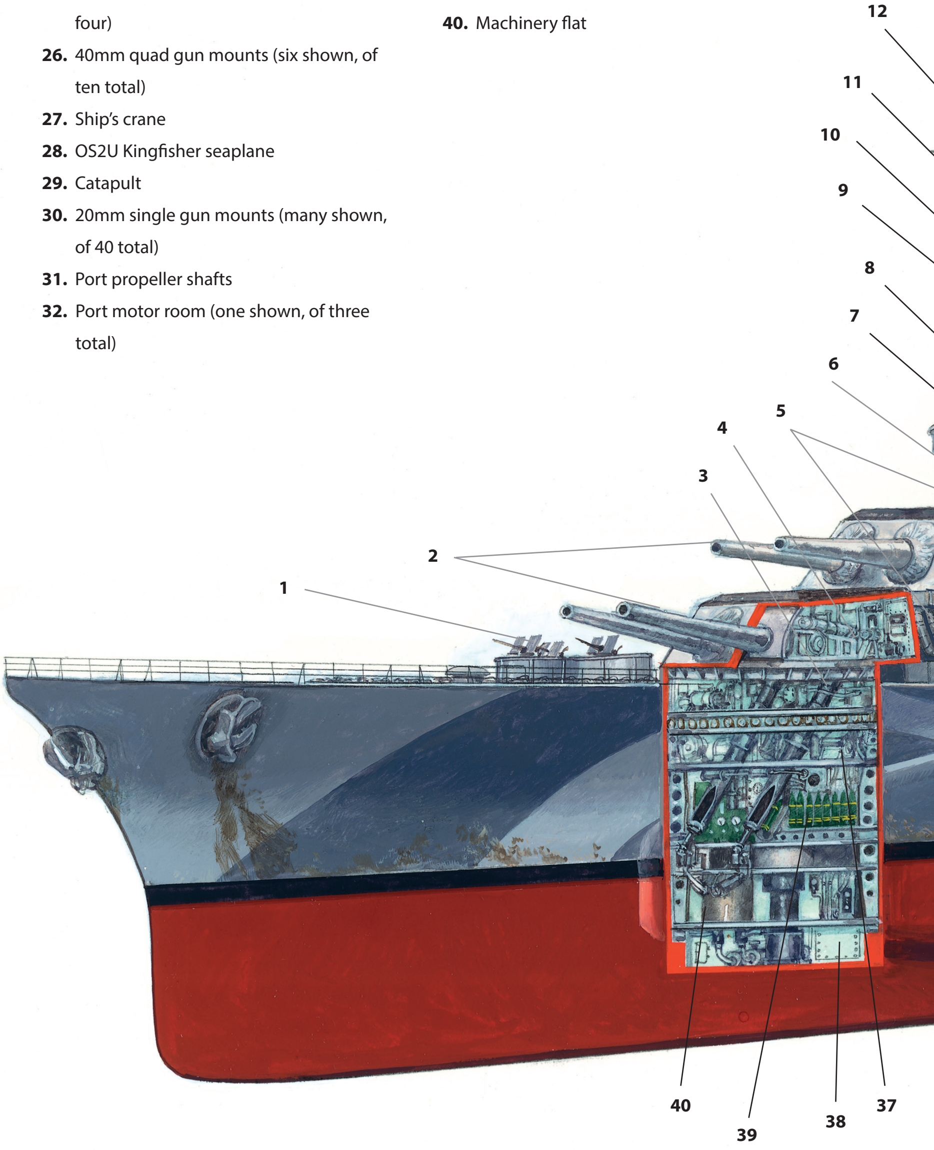
A starboard beam view of *Maryland* in August 1935. Note the secondary battery rangefinder on top of Turret Number 2; she was the only ship of her class to have the rangefinder in this position.

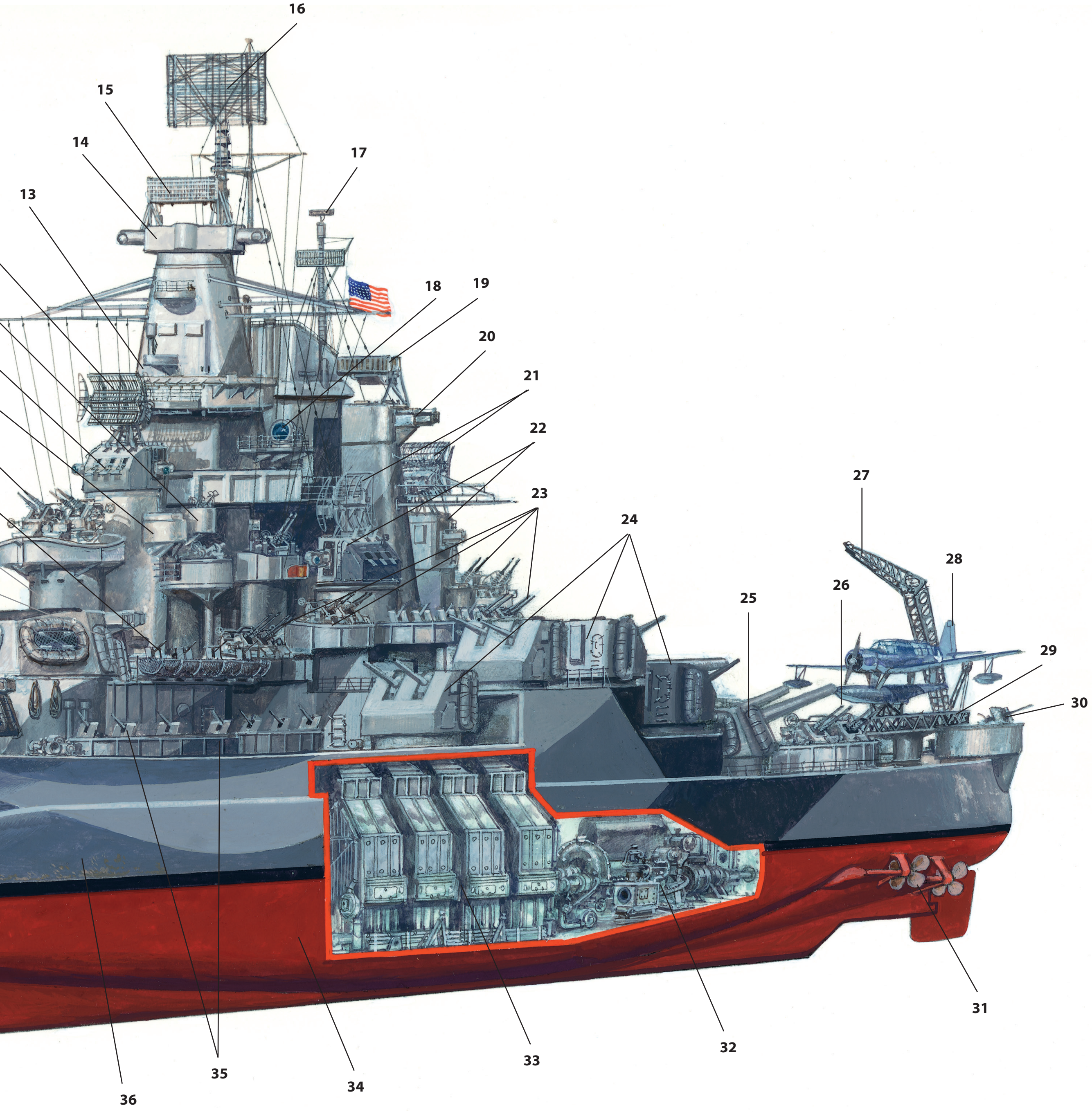
From November 1943 to January 1944, *Colorado* underwent a refit at Puget Sound. Two 5-inch/51 casemate guns were removed as were all the 1.1-inch quad mounts. In their place the much more effective 40mm

D USS *WEST VIRGINIA*

KEY

1. 20mm single gun mounts (many shown on this plate, of 40 total)
2. 16-inch/45 twin turrets (three shown, of four total)
3. Projectile hoist
4. Loading tray
5. Mk 22 rangefinder (two shown, of four total)
6. Conning tower
7. 20mm single gun mounts (many shown, of 40 total)
8. 40mm quad gun mounts (six shown, of ten total)
9. Mk 51 fire control director
10. Mk 37 directors (three shown, of four total)
11. Mk 51 fire control director
12. Mk 12/22 radars
13. Observation bridge
14. Mk 34 main battery directors
15. Mk 8 (FH) fire control radar
16. SK air search radar
17. SG-1 surface search radar
18. Searchlight
19. Mk 8 (FH) fire control radar
20. Mk 34 main battery directors
21. Mk 12/22 radars
22. Mk 37 directors (three shown, of four total)
23. 40mm quad gun mounts (six shown, of ten total)
24. 5-inch/38 twin gun mounts (four shown, of eight total)
25. 16-inch/45 twin turrets (three shown, of four)
26. 40mm quad gun mounts (six shown, of ten total)
27. Ship's crane
28. OS2U Kingfisher seaplane
29. Catapult
30. 20mm single gun mounts (many shown, of 40 total)
31. Port propeller shafts
32. Port motor room (one shown, of three total)
33. Port boiler rooms (four shown, of eight total)
34. Antitorpedo bulge
35. 20mm single gun mounts (many shown, of 40 total)
36. Measure 32/7D camouflage scheme
37. Powder flat
38. Magazine
39. Shell flat
40. Machinery flat

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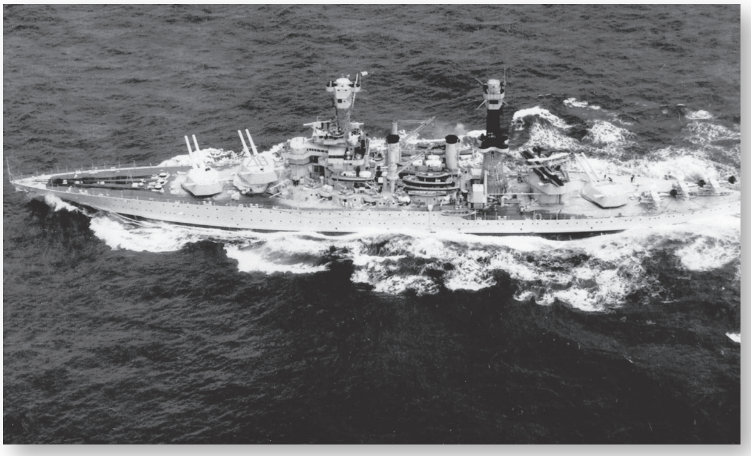


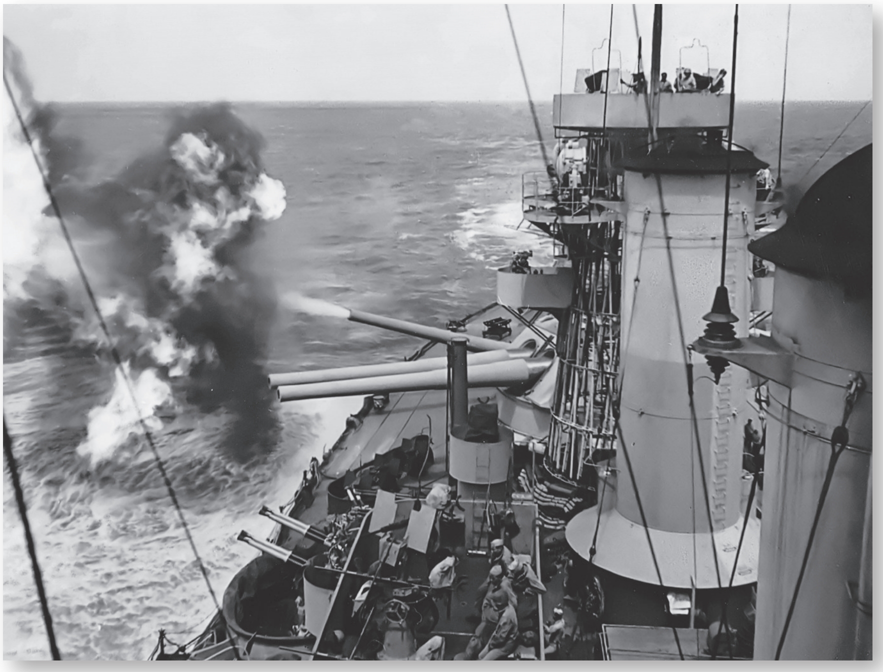
This aerial oblique of *West Virginia* on April 6, 1937 shows many of the features of this class. All four twin 16-inch turrets are trained to starboard as is the secondary battery rangefinder located abaft the conning tower. The port-side secondary battery is evident with five 5-inch/51 guns in casemates and one on the level above. The four 5-inch/25 antiaircraft guns are also evident above the casemates.

gun was added in the form of six quad and four twin mounts; a total of 42 single 20mm guns were also fitted. The catapult on Turret Number 3 was removed and an SK radar replaced the SC set. In 1944, the aft cage mast was removed and replaced by a small tower structure. The twin 40mm mounts were replaced by quads for a total of 40 40mm guns.

Maryland went to Puget Sound after Pearl Harbor and received modifications similar to *Colorado*. In 1941, before the US entered the war, she had received bulges and four 1.1-inch quad mounts. Now she received splinter shields for the 5-inch/25 mounts, 16 single 20mm guns and the SC radar and two Mk 3 fire-control radars.

The next refit for *Maryland* was in February 1943 when two more 1.1-inch quad mounts were added and the total of 20mm guns rose to 48. The SK radar replaced the SC, and Mk 4 radars were fitted on the secondary battery directors.

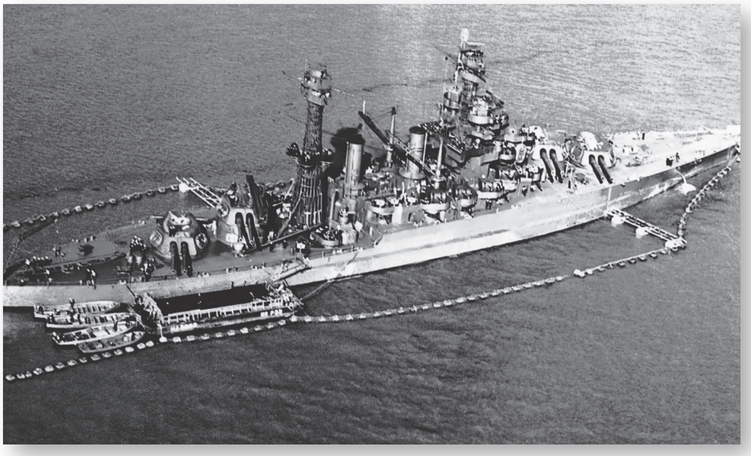
Maryland's first large modernization occurred in early 1944. All the 1.1-inch quad mounts and two 5-inch/51 guns were removed and replaced by six quad and four twin 40mm mounts. To save weight, the catapult on Turret Number 3 was removed and the mainmast cut down and 20mm guns added on top of the stump. All .50-caliber machine guns were removed; a total of 40 single 20mm guns were fitted. In a second modernization period later in 1944, the aft cage mast was removed and replaced by a small tower. The



The aft 16-inch batteries on *Colorado* firing on November 5, 1943. Note that the aft cage mast has been cut down and three 20mm guns placed on the stump. Four powerful searchlights remain on the aft cage mast.

twin 40mm mounts were replaced by quads for a total of 40 40mm guns, and the 20mm total was raised to 48. An SK radar replaced the SC set.

In May 1945, the battleship's last reconstruction was begun. All casemate guns were removed along with the 5-inch/25 battery, and were replaced with eight twin 5-inch/38 mounts. A lighter conning tower with only 1.2-inch thick armor was fitted to compensate for extra top weight. The 20mm battery was reduced to 18 twin mounts. The radar suite was refreshed with an SK-2 air-search set, and a Mk 13 radar on the aft fire-control director. The Mk 37 dual-purpose directors were provided with the latest Mk 12/22 radars.

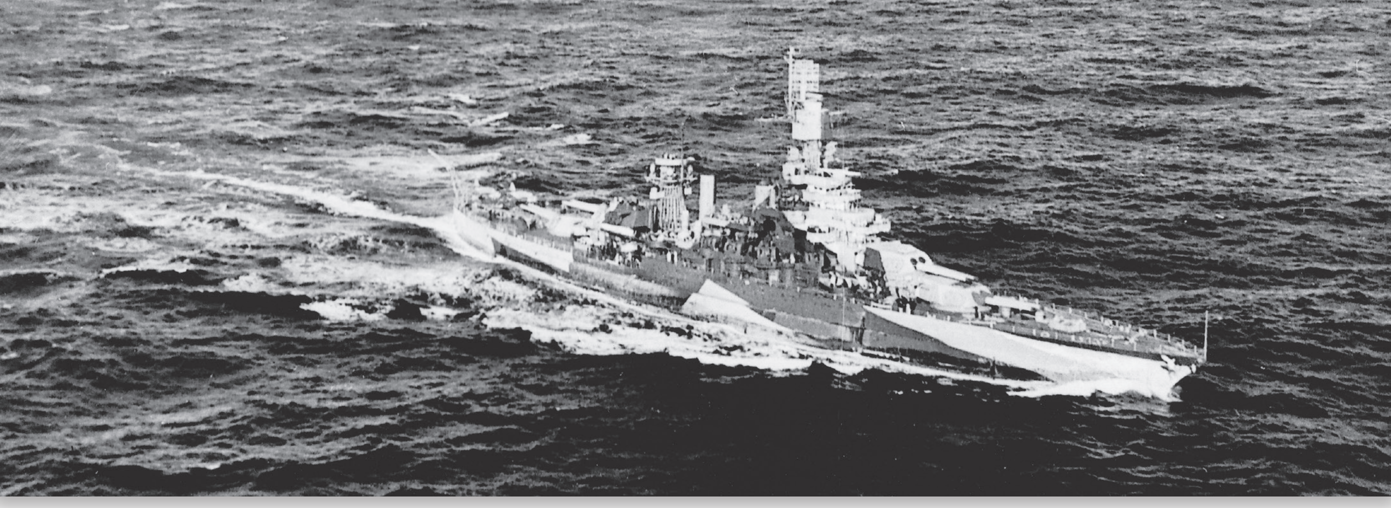


Colorado in March 1942 after completion of her first wartime modernization. Little has changed at this point since she retains both cage masts and both catapults. An SC radar is mounted on the forward cage mast, the 5-inch/25 guns have received shields, and some of the 14 20mm single mounts can be seen. The two starboard-side quad 1.1-inch mounts can be discerned abreast the aft cage mast and on the forward part of the superstructure. Of the three ships in her class, *Colorado* underwent the least modification during the war.

Wartime Modifications to Colorado Class Battleships

	5-inch/51	5-inch/25	5-inch/38	40mm	1.1-inch/3-inch	20mm
Colorado (12/41)	10	8	0	0	0	0
Colorado (2/42)	10	8	0	0	4	14
Colorado (11/43)	8	8	0	32	0	42
Colorado (1944)	8	8	0	40	0	40
Maryland (12/41)	12	8	0	0	4	0
Maryland (2/42)	12	8	0	0	4	16
Maryland (2/43)	10	8	0	0	6	48
Maryland (11/43)	10	6	0	32	0	40
Maryland (early 1944)	10	6	0	40	0	40
Maryland (5/45)	0	0	16	40	0	36
West Virginia (12/41)	12	8	0	0	0	0
West Virginia (7/44)	0	0	16	40	0	40
West Virginia (1945)	0	0	16	40	0	64

West Virginia began the war as the only ship in her class with radar since she had the experimental CXAM set fitted on the forward cage mast. From the summer of 1942 until June 1944, *West Virginia* was rebuilt. The entire look of the ship was altered with the existing superstructure being removed and replaced by a new one like that fitted on *Tennessee*. The addition of 8 foot 3 inch bulges in each side increased the beam to 114 feet, which meant



Maryland shown on March 2, 1944 in this oblique aerial view. The ship's Ms 32 dazzle camouflage scheme obscures much detail, but several of the features of *Maryland*'s modernization can be seen. The after cage mast has been cut down, and an SK radar is atop the forward cage mast. The catapult on top of Turret Number 3 is gone, and some of the augmented antiaircraft suite can be discerned. The mainmast has been cut down and three 20mm guns placed on the stump. Four powerful searchlights remain on the aft cage mast.

the ship could no longer use the Panama Canal. The number of longitudinal torpedo bulkheads increased from six to eight and an extra 3 inches of horizontal armor was added over the magazines and 2 inches over the machinery spaces. To compensate for the extra weight, the conning tower was replaced with one from a Brooklyn class cruiser and the catapult on top of Turret Number 3 was deleted.

The main battery remained, but all the old 5-inch guns were removed and replaced by eight twin 5-inch/38 mounts. Ten 40mm quad mounts and 40 20mm single guns were added. Fire control was drastically improved with Mk 34 directors with Mk 8 radars for the main battery and Mk 37 directors with Mk 4 radars for the secondary battery. The rest of the radar equipment included an SK set on the foremast and one SG radar on the foremast and mainmast. The ship stayed in this basic configuration for the rest of the war. In 1945 the 20mm suite was modified to 58 single, one twin, and one quad mount. The SK-2 radar replaced the SK. At the end of the war, displacement had risen to 37,800 tons (40,396 tons full load).

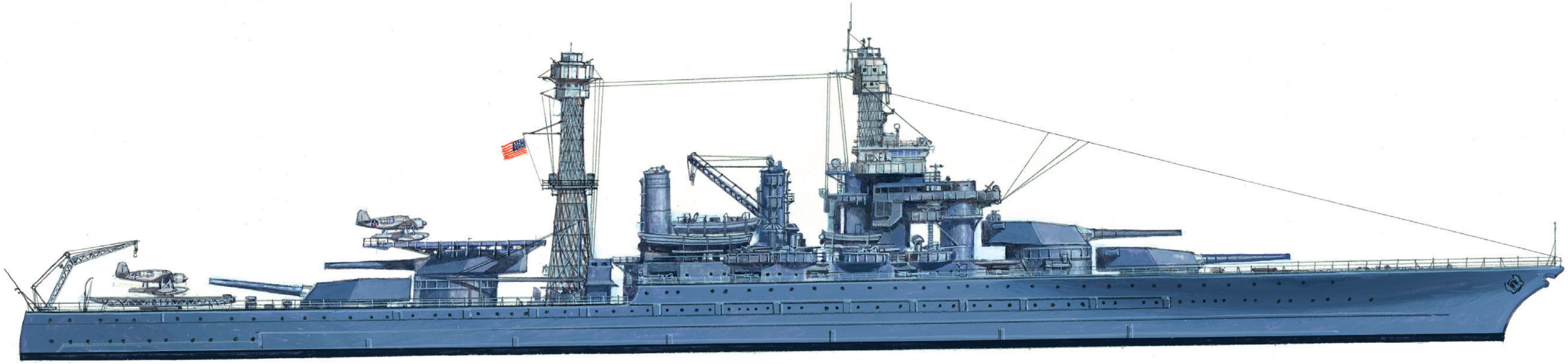
Wartime Service

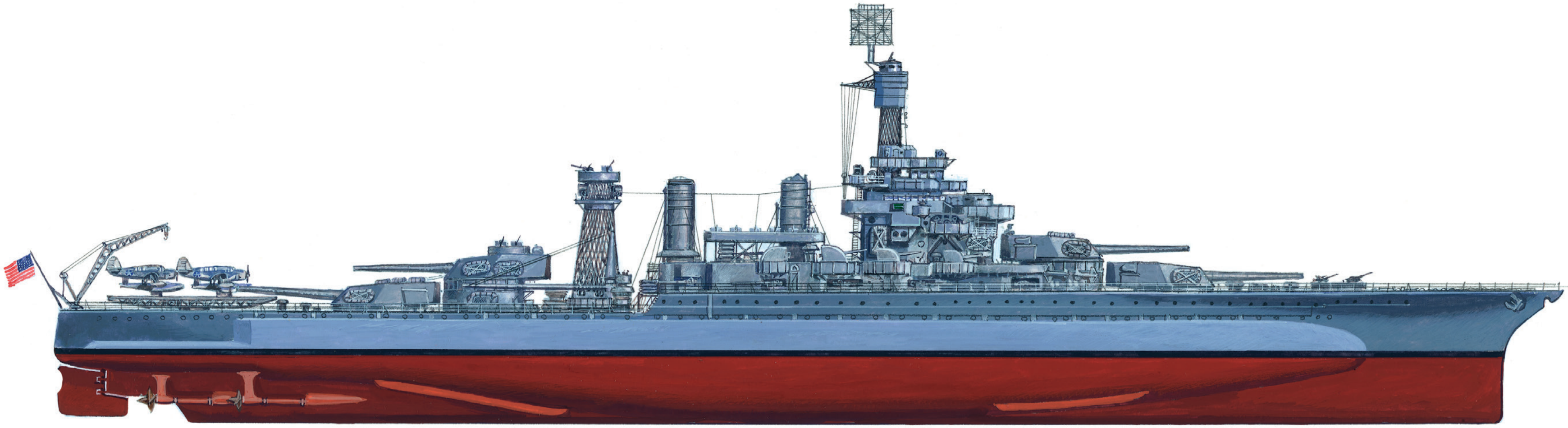
After being commissioned on August 30, 1923, *Colorado* was assigned to the Pacific Fleet the following year. Aside from short stints in the Caribbean during exercises or in East Coast shipyards, *Colorado* spent her entire career in the Pacific. As war approached, *Colorado* departed Pearl Harbor in June 1941 and steamed to Puget Sound Navy Yard for a limited modernization. This meant she was the only Pacific Fleet battleship not in Pearl Harbor on December 7, 1941.

E

THE COLORADO CLASS

The top profile depicts *Colorado* as she appeared in 1941 before going into refit and limited modernization before the opening of war. The ship retains her two prominent cage masts and two catapults. The secondary battery of six 5-inch/51 guns is evident with five of the guns in casemates. The sixth gun is located on the second level abaft Turret Number 2. The starboard-side antiaircraft guns include four 5-inch/25 mounts without shields on the second level and two single 3-inch guns. The second profile is of *Maryland* in early 1943 as she appeared in mid-war after minor modifications. The ship retains ten 5-inch/51 guns in casemates and eight 5-inch/25 mounts with shields. The aft cage mast has been cut down and three 20mm single guns placed on top. Other 20mm guns are evident on two galleries built abeam the forward stack and near Turrets 2 and 3. The turret-mounted catapult has been removed. The ship is in the Ms 21 camouflage scheme.





OPPOSITE
An aerial starboard bow view of *West Virginia* on June 1, 1944 shows the result of her modernization. An entire new superstructure is evident with a Mk 34 director equipped with the Mk 8 radar on top. The large radar above the superstructure is the SK and an SG radar is fitted on top of both pole masts. The extensive antiaircraft battery of quad 40mm and single 20mm mounts is evident, as is the new secondary battery of twin 5-inch/38 mounts. The ship is in the Ms 32/7D dazzle scheme.

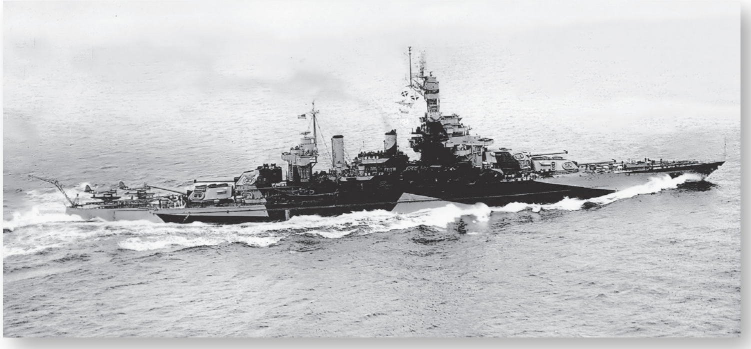
The battleship's overhaul was completed as soon as possible and on February 26, 1942, she departed for San Francisco where the USN was assembling a new battle line in the aftermath of the Pearl Harbor attack. Initially, *Colorado* joined with *Maryland* and *Tennessee*, both Pearl Harbor survivors, and *Mississippi* which was transferred from the Atlantic. *Idaho* and *New Mexico* later joined this force which was designated Task Force 1. The USN's older battleships were never committed to the grinding battle of attrition during the Guadalcanal campaign, but *Colorado* and *Maryland* were used to defend the Fiji Islands, New Caledonia, and the New Hebrides Islands in late 1942 and into 1943.

When she returned to service, *Colorado* bombarded Apamama Atoll in the Gilberts on November 20, 1942, and then followed up with a similar treatment of Tarawa. On November 29, the ship departed for Pearl Harbor and then for Puget Sound for overhaul. *Colorado* returned in time for the invasion of the Marshall Islands. She was assigned to support the landing on Kwajalein Atoll which occurred on January 31. The atoll was secured on February 4 which released *Colorado* to join the bombardment of the next target, Eniwetok. She left the combat zone on February 23 and proceeded to Puget Sound for her second wartime overhaul.

Coming out of overhaul on April 30, she joined the forces earmarked for the invasion of the Mariana Islands, On June 14, *Colorado* began bombarding Saipan and supported the landing the following day. When the carrier clash during the battle of the Philippine Sea was fought, *Colorado* patrolled to the west of Saipan to intercept any IJN forces which broke through to the beachhead. After Saipan was secured on July 8, Guam was next. Thirteen days of preparatory fire led to the landing on July 21. After supporting operations ashore, *Colorado* headed over to Tinian. On July 23, she took out a 5.5-inch shore battery on the island. The following day she came under fire from a 6-inch shore battery and she was struck by 22 shells. Damage was not enough to send her home, but personnel casualties were heavy with 43 killed and 97 wounded. *Colorado* stayed on station until 3 August.

Colorado arrived at Puget Sound in late August for repairs, overhaul, and modernization. This was concluded on 5 October after which the battleship proceeded to the Philippines where the campaign for Leyte was already in progress. On November 27, she was struck by a kamikaze which killed 19 and wounded 72. In early December, the battleship supported the invasion of Mindoro. On January 6, 1945, she began preliminary operations for the invasion of Luzon. On January 9, in the Lingayen Gulf, she was struck by a 5-inch shell in the forward superstructure which killed 18 and wounded 51. Since the damage was minor, she was able to remain on station until February 14.

During the Okinawa campaign, *Colorado* participated in the pre-invasion bombardment of the island. After 63 consecutive days on the gun line, she retired. Upon returning to the forward areas, *Colorado*'s crew received news of the Japanese surrender. After supporting the landing of occupation troops on Japan, *Colorado* returned to the



Maryland shown in 1944 after the aft cage mast had been removed and replaced with a small superstructure. The electronics fit can be seen with SK radar on the forward cage mast and SG radars atop both pole masts. The Mk 3 fire control is evident on top of the directors atop the remaining cage mast and the aft superstructure.

United States in October. During her active wartime career, she earned ten Battle Stars. An indication of the intensity of the 204 days she spent in combat operations is her expenditure of 5,495 16-inch rounds, 10,197 5-inch/51 and 11,585 5-inch/25 rounds. On January 7, 1947, she was placed in reserve; in 1959 she was sold for scrap.

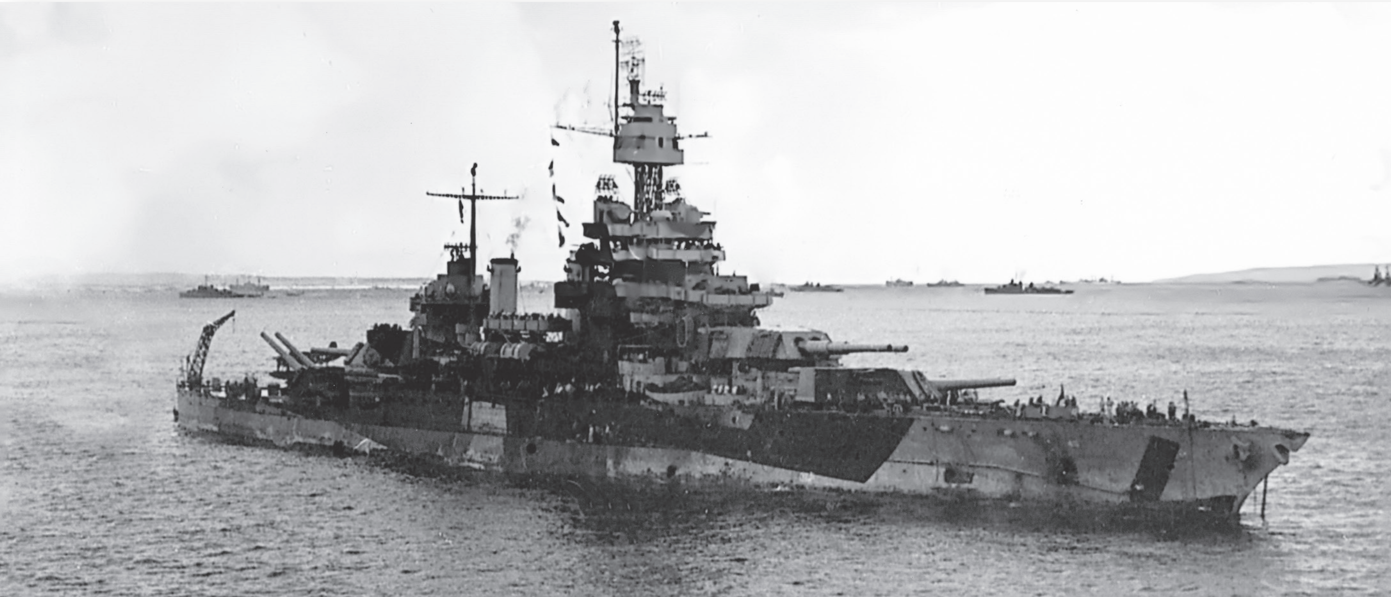
As the first ship of the USN's most powerful class of battleships, *Maryland* was much in demand upon her commissioning in 1921. In 1923, she joined the Pacific Fleet where she spent the rest of her career. At Pearl Harbor, *Maryland* was moored outboard of *Oklahoma*, so she was not exposed to torpedoes and therefore escaped major damage. *Maryland* was the least damaged ship on Battleship Row. The ship was hit by a single 1,760-pound bomb on the forecastle below the waterline. A second bomb hit the forecastle but caused little damage. Only four crewmen were killed and 14 wounded. On December 30, she arrived at Puget Sound for permanent repairs.

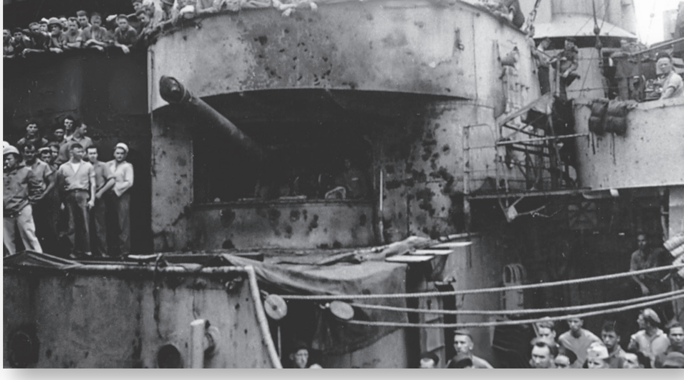
After completion of these repairs, *Maryland* joined Task Force 1. In November, she headed south to the Fiji Islands to defend the sea lanes to Australia. In February 1943, she moved to the New Hebrides and remained in the South Pacific until August 1943 when she returned to Pearl Harbor.

In October, *Maryland* departed Hawaii to prepare for the invasion of the Gilberts. On November 20, she arrived off Betio Island. *Maryland* was the flagship of the bombardment force, but was plagued with communications problems caused by the shock of firing her 16-inch guns. Following a quick refit, the battleship bombarded Roi in Kwajalein Atoll on February 1, 1944. After this, the battleship departed for Puget Sound and a second round of modernization.

Maryland returned to action in time for the invasion of Saipan. Just after dusk on June 22, a single G4M Betty executed an attack on *Maryland* anchored off Saipan. The aircraft launched a single torpedo which hit the bow on the

On July 24, 1944, *Colorado* was struck by 22 shells from a Japanese shore battery on Tinian. This type of shell could not penetrate to the vitals of the ship, but it could penetrate unarmored areas of the hull and the bulge amidships. Note the aft cage mast has been replaced by a small superstructure. The Ms 32/16D dazzle scheme makes it hard to pick out details, but her electronics fit is clearly visible with an SK radar atop the forward cage mast and SG radars on both pole masts.





LEFT
On November 27, 1944, *Colorado* was struck by a kamikaze while operating in Leyte Gulf. The smoke from the explosion on the battleship is evident in this photo. Another kamikaze can be seen to the left headed for the ship.

RIGHT
The kamikaze hit aft near a 5-inch/51 casemate gun, ripping a hole in the deck and putting the gun out of action. Personnel casualties included 19 dead and 72 wounded, but the ship remained in action.

port side. Two men were killed, but the bulkheads held and therefore damage was limited. *Maryland* was forced to return to Pearl Harbor where a new bow was built and welded on in 34 days. She departed Hawaii on August 13 to take part in the invasion of the Palau Islands. On September 12, she shelled Peleliu and remained on station until the end of the month.

On October 19, she took part in the pre-invasion bombardment of Leyte, and on October 25 participated in the battle of Surigao Strait. On November 27 and 28, *Maryland* was exposed to kamikaze attack, but suffered no damage. On November 29, her luck ran out. Three incoming kamikazes were destroyed, but another hit the forecastle between Turrets 1 and 2. The kamikaze's bomb penetrated to the main deck where it exploded causing a large fire and heavy casualties (31 dead and 30 wounded). The battleship was forced to return to Pearl Harbor for repairs.

In February, after repairs were completed, work-ups began for the next operation – the invasion of Okinawa. After pounding the island from March 26, *Maryland* was hit by another kamikaze on April 7, 1945. The impact took place on the top of Turret Number 3, but did not penetrate; however, the 20mm gun stations on top of the turret were devastated with ten dead, six missing, and 37 wounded.

The ship stayed on station until April 14, and then departed for a third round of modernization. By the time she returned to service, the Japanese had surrendered. During her Pacific battles, the ship fired 3,479 16-inch shells, 13,972 5-inch rounds, and earned seven Battle Stars. On July 15, 1946, *Maryland* was placed in reserve and stricken from the Naval Register on March 1, 1959.

West Virginia was caught in Pearl Harbor on December 7, 1941. The ship was in a very vulnerable position moored outboard of *Tennessee* directly in the path of 29 Japanese torpedo bombers. In just minutes she was hit by a probable seven torpedoes. The ship took a list of 28 degrees, but this was reduced by quick orders to flood the voids on the starboard side which reduced the list to 15 degrees and allowed the ship to settle and avoid capsizing. In addition to the torpedo barrage, the ship was hit by a 1,760-pound armor-piercing bomb that penetrated the main deck and wrecked the port casemates. After the conclusion of the attack, the ship was engulfed in flames which forced the crew to abandon

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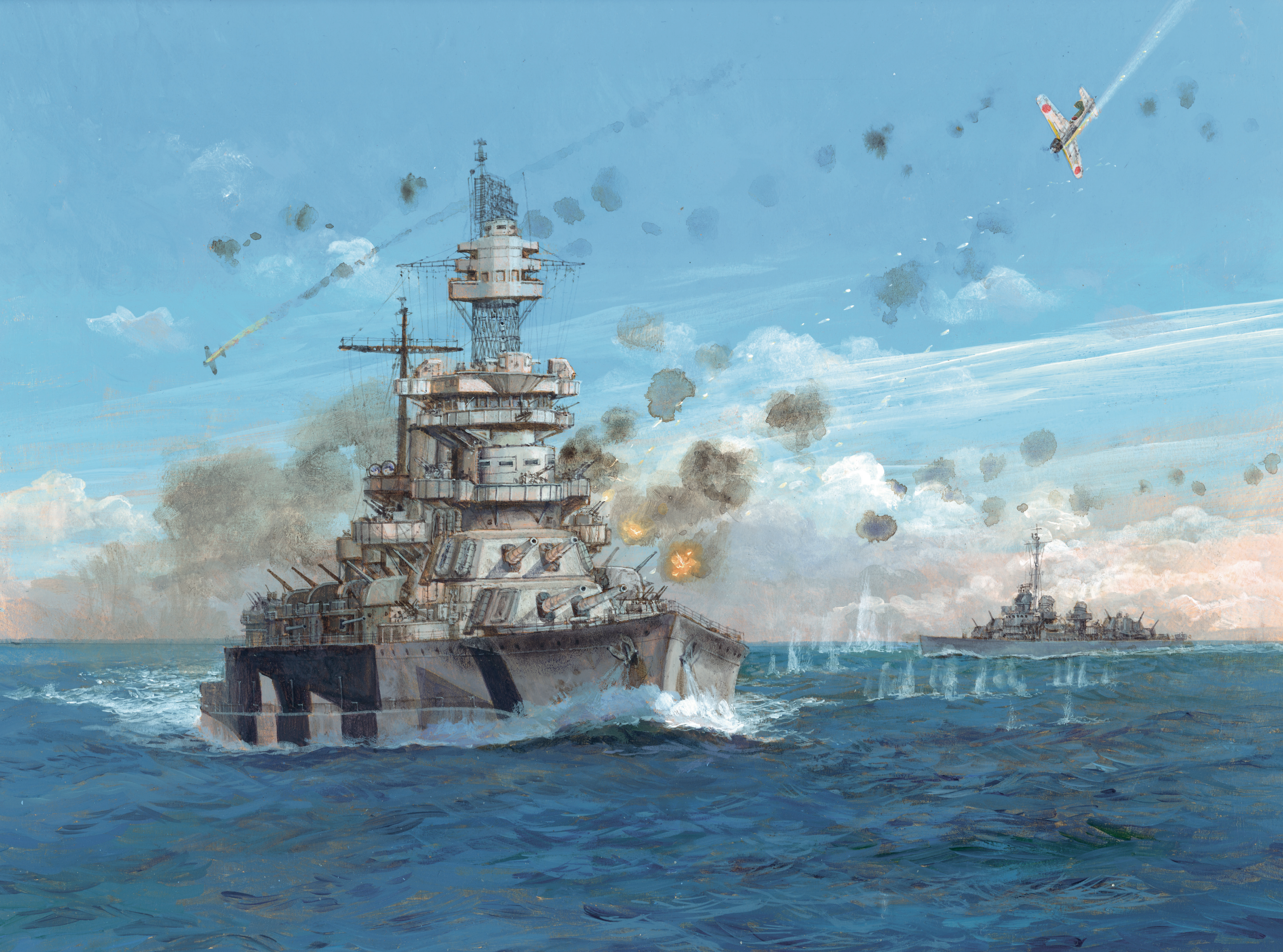
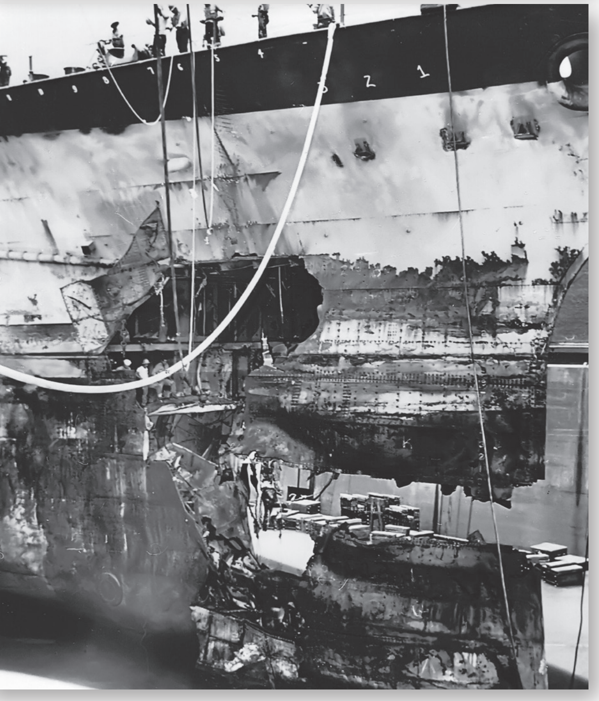
COLORADO UNDER KAMIKAZE ATTACK

On November 27, 1944, while operating off Leyte in the Philippines, *Colorado* came under kamikaze attack. Despite a heavy barrage of antiaircraft fire, one suicide aircraft hit the battleship. The damage caused was insignificant, but personnel casualties were heavy with 19 dead and 72 wounded. The ship is shown here in an Ms 32/16D dazzle scheme. Note that her late-war configuration includes the removal of the aft cage mast and its replacement with a small superstructure upon which one of the two main battery directors is located. Even in late 1944, *Colorado* retains eight 5-inch/51 casemate guns and eight 5-inch/25 mounts with shields.





ship. Despite this grievous damage, personnel casualties were not extremely heavy, but 105 were killed and another 52 wounded.

The USN spared no effort in salvaging *West Virginia*. By May 17, 1942, the ship was raised off the harbor floor and moved into drydock to have her torpedo damage patched. On May 7, 1943, the ship left Pearl Harbor and headed for Puget Sound for modernization. This work lasted until June 4, 1944, when she got underway to start trials. Her first action was supporting the invasion of Leyte. On October 19, she shot 278 16-inch and 1,586 5-inch shells. The next day she shot another 240 16-inch rounds in support of ground operations. At Surigao Strait she fired 16 salvoes at the battleship *Yamashiro*.

In December, she covered the landings on Mindoro, fighting off kamikazes. This was followed by the January 1945 invasion of Luzon. On three days, between January 7 and 9, *West Virginia* expended 395 16-inch and over 2,800 5-inch shells. Beginning on February 19, the battleship started to pound Iwo Jima, remaining off the island providing support until March 4. Next up was Okinawa. She began pounding Japanese beach defenses on March 26, but on the day of the landing was struck by a kamikaze. The aircraft hit the superstructure just forward of the port-side secondary fire director. Only four were killed and seven wounded in the nearby 20mm gun station. The bomb aboard the aircraft penetrated to the level below, but did not explode. Undeterred, the battleship stayed on station until the end of June. After a brief respite in July at Leyte, she returned to Okinawa on August 6. On August 31, she sailed into Tokyo Bay, the first of the old battleships to do so.

Despite her late start in the war, *West Virginia* spent 223 days in combat areas and expended over 3,000 16-inch shells and some 30,000 5-inch rounds. She received five Battle Stars for her exploits. The veteran battlewagon was decommissioned on January 9, 1947; on March 1, 1959 she was stricken and sold for scrap in August of that year.

TOP
Maryland's 16-inch guns fire a salvo against Japanese defenses on Okinawa on May 3, 1945. Okinawa was the final battle for the USN's older battleships, and ten of the 13 ships in service in 1945 saw action there.

BOTTOM
On June 22, 1944, *Maryland* was torpedoed by a Japanese aircraft. The torpedo hit on the bow, causing the damage shown here in this November 4, 1944 shot from the drydock in Pearl Harbor.

Colorado Class Specifications (as built)	
Displacement	31,800 tons standard; 33,590 tons full load
Dimensions	Length 624 ft overall; Beam 97 ft 5 in.; Draft 30 ft 2 in.
Speed	21 kts
Range	8,000m at 10 kts
Crew	1,083

South Dakota Class

Design and Construction

The South Dakota class grew out of the concern during World War I that the USN was falling behind the other great naval powers. The urgency of

improving the Navy's fighting power also seemed more imperative as events in Europe edged the United States toward war. Traditionally Congress had been reluctant to authorize large naval budgets, but the looming prospects of war changed that. In 1916, a bill was passed to authorize the USN to build ten capital ships – four in 1917, and three each in 1918 and 1919. The six latter ships were approved to be much larger than existing ships; these were to become the South Dakota class.

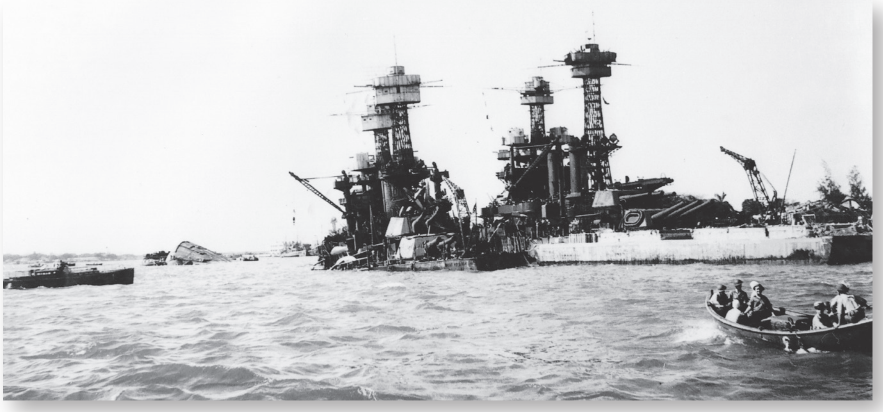
From the Nevada class onward, USN battleship design had been largely uniform. Now the General Board wanted a ship with much greater capabilities which would require a much greater displacement. The new class had to carry 16-inch guns since there were indications that the Japanese were moving to a 15-inch gun and that the British were considering 18- or 19-inch guns. There were also concerns that foreign battleships were emphasizing greater speed. However, the General Board was not as concerned about producing a design with greater speed, and called for an increase of only two knots over earlier designs for a new maximum speed of 23 knots.

With the basic requirements for a ship with 12 16-inch guns, 23-knot speed, and in the 700-foot, 40,000-ton range, design work began in 1916. It was quickly decided that the guns would be mounted in four triple turrets and protection was to be improved based on reports from Europe. To achieve the desired 23-knot speed, 60,000 hp from 12 boilers was required. Just like on the New Mexico, Tennessee, and Colorado classes, turbo-electric drive would be used to drive the four shafts. The great length of the machinery spaces required that the conning tower and forward fighting top be combined into a single structure to keep the foremast far enough away from the forward stack.

The 1918 and 1919 battleships were not laid down as scheduled because of the wartime requirement for more destroyers and merchant ships to contend with the U-boat threat. This delay in construction allowed the design

LEFT
Maryland shown after the attack on Pearl Harbor. The capsized *Oklahoma* is in the foreground; her positioning saved *Maryland* from torpedo damage which meant that the battleship received only minor bomb damage.

RIGHT
The bombardment of Betio Island in the Tarawa Atoll taken from *Maryland* on November 20, 1943. The intensity of the bombardment appears to be overwhelming; in fact it did cause considerable damage to the defenders, but was inadequate to prevent a vicious and costly three-day battle for control of the island.



West Virginia shown on December 7, 1941 after settling to the floor of Pearl Harbor after taking seven torpedoes. Quick damage control work prevented her from capsizing which was the fate of *Oklahoma* seen just forward of *West Virginia*. *Tennessee* is moored to *West Virginia*'s starboard side and only took two bombs during the Japanese attack.

LEFT
West Virginia shown after her salvage and following temporary repairs that permitted her to proceed to Puget Sound for reconstruction. The hull shows no sign of the extensive torpedo damage. Once she arrived at Puget Sound, everything except the main battery was removed and the ship was rebuilt from the main deck up.

RIGHT
West Virginia on November 9, 1944 in drydock. The ship was basically unchanged following her modernization, but an SK-2 radar has replaced the SK. This view shows the ship's immense beam (114 feet) which was the largest of any USN battleship and prevented her from using the Panama Canal.

to be further refined. It also gave the designers time to benefit from British wartime experience, knowledge of which was forthcoming after the United States entered the war. Implementing any changes was very difficult since the ship was already at its maximum displacement. Beam was limited to a maximum of 106 feet by the requirement to be able to use the Panama Canal and maximum draft was also a concern because of the depth of existing bases. Changes that were made included greater elevation for the main battery, more armor on the main battery turret roofs to protect against plunging fire, and more deck armor. Final plans were approved in July 1918 so that construction could begin in 1920.

South Dakota Class Construction

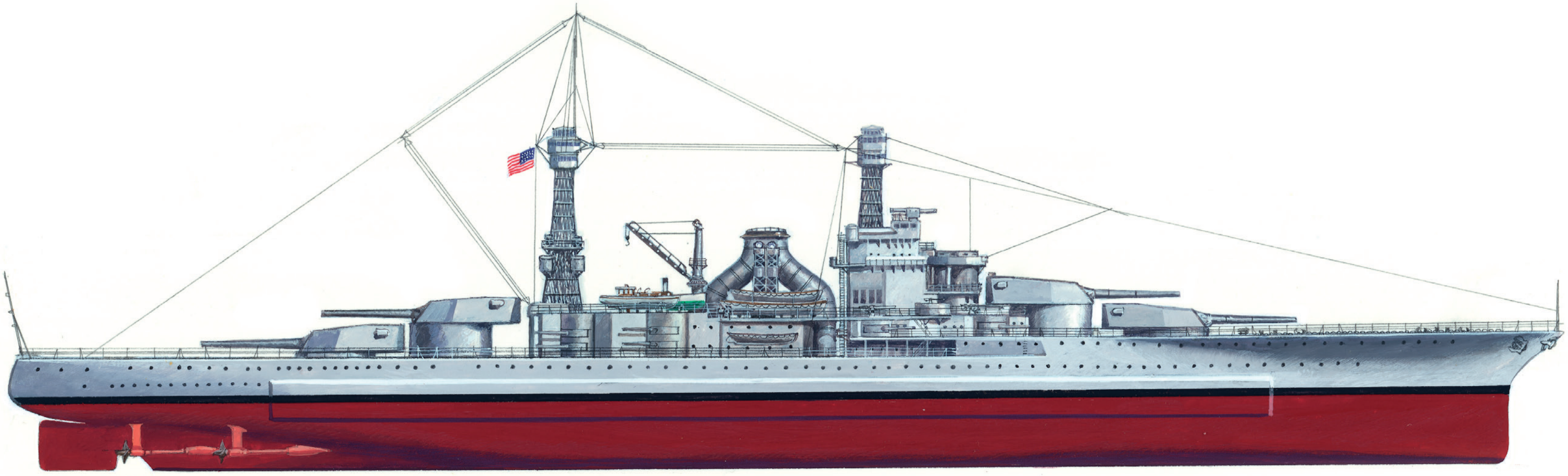
Ship	Built at	Laid down	Launched	Percent complete when cancelled
South Dakota	New York Navy Yard, NY	15/3 /20	Never	38.5
Indiana	New York Navy Yard, NY	1 /11/20	Never	34.7
Montana	Mare Island, CA	1/9 /20	Never	27.6
North Carolina	Norfolk, VA	12/1 /20	Never	36.7
Iowa	Newport News, VA	17/5 /20	Never	31.8
Massachusetts	Quincy, MA	4/4 /21	Never	11.0

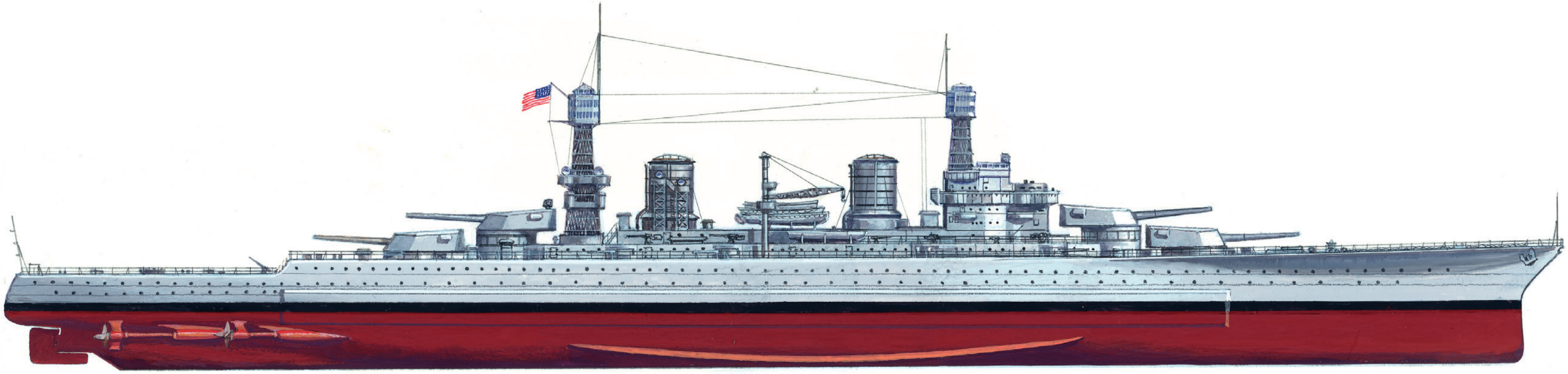
Had they been completed, the South Dakota class would have presented a different appearance from previous USN battleships. The ships retained the clipper bow of the later battleships, and had the basic configuration of four main battery turrets and two large masts. What would have been different

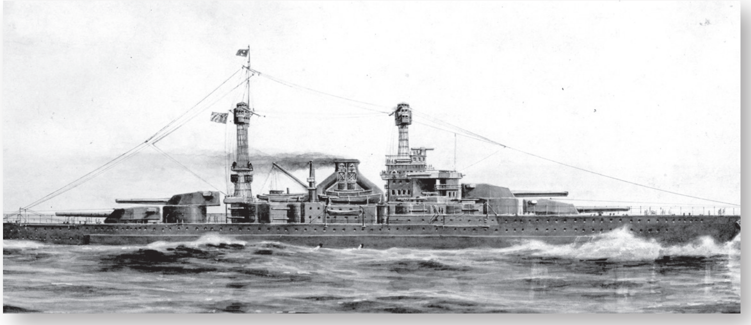
G

THE UNFINISHED CLASSES

The top profile represents battleship *South Dakota* had she been completed. The design is clearly based on that of the preceding Colorado class with several distinguishing differences. The main difference is the adoption of triple 16-inch turrets to replace the twin turrets on the Colorado class ships. The South Dakota class kept the typical USN cage masts and a superstructure based on the previous classes, but the single trunked stack is unique. Also note the different arrangement of the secondary battery. The lower profile features battlecruiser *Lexington* had she been completed. The ship gives an impression of speed with her enormous length and two massive stacks serving 16 boilers. The main battery consisted of eight 16-inch guns in four twin turrets. Not evident is the inadequate armor protection featuring a 7-inch main belt.







The artwork from about 1920 shows the intended appearance of the uncompleted South Dakota. Its similarities with the Colorado class are obvious, but some differences are also evident.

was the forward superstructure which combined the conning tower and the foremast and the unique trunked stack. The placement of the secondary battery was also improved since it moved the guns higher off the main deck.

Protection was generally similar to earlier classes. The main belt and armored bulkheads had a maximum of 13.5 inches of armor which tapered to 8 inches. The main armor deck was 6 inches in two layers plus a 1-inch splinter deck. The four main battery turrets were protected with 18 inches on their face, 5 inches on the roof, 10 inches on the side, and 9 inches on their rear. The conning tower was protected by 16 inches. The total weight of armor was 14,805 tons.

Armament

A major improvement was the mounting of the new 16-inch/50 gun. The final armament was set at 12 of these weapons mounted in four triple turrets. This would have made them the most heavily armed USN battleship afloat and would not be matched until the design of the Montana class authorized in 1940. The weight penalty of a more powerful secondary battery was accepted and it was planned to mount a 6-inch/53 gun in 16 single mounts. Had they been completed the South Dakota class would have been the only USN battleship class to carry a 6-inch secondary battery. Antiaircraft protection was to be provided by eight single 3-inch/53 mounts and two submerged 21-inch torpedo tubes were also planned.

Fate

The post-war discontent with large and seemingly unnecessary naval budgets meant the end of the South Dakota class. All principal naval powers had common cause to agree to reduce naval expenditures. The ultimate result was the Washington Naval Treaty signed on February 8, 1922. Commensurate with the treaty, the entire class was cancelled; construction had been between 11 and 38.5 percent complete when construction was stopped. The entire class was scrapped, a process which was complete by November 1924. The ships did offer some value to the USN since the boilers and armor intended for the class were used in the reconstruction of existing battleships. All of the names for the six ships in the class were used for future battleships.

South Dakota Class Specifications (as designed)	
Displacement	41,400 tons standard; 43,200 tons full load
Dimensions	Length 684 ft overall; Beam 106 ft; Draft 33 ft
Speed	23 kts
Range	8,000m at 10 kts
Crew	1,191

Lexington Class Battlecruisers

Design and construction

The only class of battlecruisers ever laid down by the USN was the Lexington class. The Alaska class of large cruisers completed late in World War II were just that – large cruisers and not true battlecruisers. The six ships of the Lexington class were never completed, though two (*Lexington* and *Saratoga*) were converted into carriers and enjoyed long and largely successful careers.

With the advent of the battlecruiser in 1906, the Royal Navy, followed by the Imperial German Navy and later by the IJN, all made heavy investments in this type of ship. The USN resisted the temptation to follow suit, not because they didn't think battlecruisers would be useful, but because of low naval budgets. Faced with a choice of battleships or battlecruisers, the USN chose more battleships.

The USN's chance to get into the battlecruiser game came in 1916 when Congress passed a large naval appropriation. This included six battlecruisers and other supporting ships to create a balanced battle fleet. However, as was the case for the other major component of the 1916 naval budget, the South Dakota class, construction on the Lexington class was deferred until after the war because of the need to concentrate on construction linked to the effort to defeat the U-boat threat.

The added time gave designers the opportunity to produce a much better ship. Initial USN battlecruiser concepts centered around a heavily armored ship that approached the fast battleship concept. The design approved for the 1916 program was much more lightly armored and thus in the mold of a "battle scout" which could conduct reconnaissance in a fleet action and engage enemy battlecruisers but lacked the protection to take on enemy battleships. This resulted in a ship of 34,800 tons standard displacement with very light armor – 5-inch armor protection for belts, barbettes, and the conning tower. The layout of the propulsion system was unusual. With 180,000 shp needed to achieve the design speed of 35 knots, 24 boilers were needed. This meant that half of the boilers had to be placed above the main armor deck, where they would be protected only by 4-inch armor bulkheads. A total of seven stacks were needed to funnel the exhaust gasses.

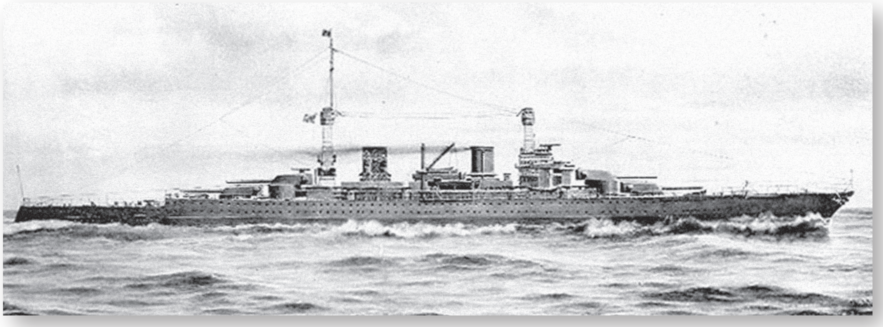
Fortunately for the USN, the time between 1916 and when construction began in 1920 was put to good use refining the design. In 1917, the main and secondary batteries were altered (see below) and the number of boilers reduced to 20 which meant all could be placed below the armored deck. The boilers used turbo-electric drive to drive the four shafts.

Lexington Class Construction

Ship	Built at	Laid down	Launched	Percent complete when cancelled
Lexington	Quincy, MA	8/1/21	3/10/25	completed as carrier
Constellation	Newport News, VA	18/8 /20	Never	22.7
Saratoga	Camden, NJ	25/9/20	7/4/25	completed as carrier
Ranger	Newport News, VA	23/6/21	Never	4.0
Constitution	Philadelphia Navy Yard	25/9/20	Never	13.4
United States	Philadelphia Navy Yard	25/9/20	Never	12.1

The final design was approved in 1918 and increased protection all around. The belt was increased to 7 inches of sloped armor and the barbette protection increased to a maximum of 9 inches and the conning tower to 12

This drawing of the unfinished Lexington class gives an impression of the size and speed of the unfinished battlecruiser. The ship retains the typical USN cage masts, but the two large, widely spaced stacks hint at the ship's high maximum speed. The large number of port-holes on the length of the hull indicate a lack of extensive armored protection.



inches. The turret face was now given 11 inches of protection and the sides 6 inches. Horizontal armor totaled 4 inches in two decks. The hull was widened to allow the installation of an anti-torpedo protection system but with the beam still within limits to transit the Panama Canal. Though the ship's total weight of armor was 12,580 tons, overall the scale of armored protection was too light. The USN stayed with its pre-war concept of building a large scout cruiser, even though the British had been forthcoming with details of their war experiences with lightly armored battlecruisers which included the destruction of three on a single day at the battle of Jutland. The USN believed that British battlecruiser disasters were due to poor anti-flash protection, not a lack of armor.

These changes increased displacement and reduced the maximum speed. The adoption of small-tube boilers translated into only 16 boilers being needed which meant that the final design had only two large stacks.

Armament

The 1916 design called for a main battery of ten 14-inch/50 guns in two triple and two dual turrets. The secondary battery comprised 18 5-inch/51 guns in casemates.

In 1917, the main battery was changed to eight 16-inch guns in four dual turrets and the secondary battery changed to 14 6-inch guns. This change was driven by the assessed armament of foreign battlecruisers. Four 3-inch antiaircraft guns were included. A total of eight torpedo tubes were planned and, uniquely for a USN capital ship, four of these placed above the waterline.

Fate

The Washington Naval Treaty cancelled the construction of these ships which had begun in 1920. The Lexington class reflected the battlecruiser's original purpose as a large scout platform, and had not evolved into the fast battleship as the latest foreign battlecruiser designs had. The Royal Navy's *Hood* was a much superior design in terms of protection and balance, so the Lexington class was already considered obsolete. Two of the ships were completed as fleet carriers and went on to serve as platforms for the development of USN carrier doctrine before the war and then with distinction during the war.

Lexington Class Specifications (1918 design)	
Displacement	43,500 tons standard; 44,638 tons full load
Dimensions	Length 874 ft overall; Beam 105 ft 5 in.; Draft 31 ft
Speed	33.5 kts
Range	12,000m at 10 kts
Crew	1,297

ANALYSIS AND CONCLUSION

The Big Five were never truly able to perform in the role for which they were intended; the closest thing to a duel with IJN battleships was the maritime execution in the Surigao Strait in October 1944. In spite of being replaced as the USN's most capable battleships by the North Carolina, South Dakota, and Iowa classes, the Big Five still made important contributions to the American victory in the Pacific.

It should be kept in mind that those members of the Big Five which were fully modernized, *Tennessee*, *California*, and *West Virginia*, were near equivalents to the USN's new battleships in combat capabilities. Their fire-control systems were equivalent to the newer ships, as were their antiaircraft capabilities. Protection was also essentially equivalent in terms of horizontal protection and anti-torpedo defenses, and the Big Five actually carried thicker main belts. The most deficient area in the Big Five's capabilities was in speed, which was not only much less than the newer battleships, but so low as to take the Big Five out of any fleet role and relegate them to supporting amphibious invasions.

The Big Five was never subjected to serious combat damage after Pearl Harbor, so it is difficult to make a useful assessment of their protection capabilities. The only torpedo damage was the single hit on *Maryland* which was on her bow and did not test her dedicated torpedo defenses. The remainder of the wartime damage was from small-caliber shore batteries or kamikazes, both of which lacked the capacity to severely damage a heavily armored battleship.

Wartime Damage to Tennessee and Colorado Classes

Ship	Agent of Damage	Date	Fate
Tennessee	2 bombs	12/7 /41	Light damage
California	2 torpedoes, 1 550-bomb	12/7/41	Sunk; later salvaged
West Virginia	7 torpedoes, 1 1780-lb bomb	12/7/41	Sunk; later salvaged
Tennessee	3 4.7-inch shells	15/6/44	Light damage
Maryland	1 torpedo	22/6/44	Moderate damage
Colorado	22 6-inch shells	24/7/44	Moderate damage
Colorado	1 kamikaze	27/11/44	Minor damage
Maryland	1 kamikaze	29/11/44	Moderate damage
California	1 kamikaze	6/1/45	Moderate damage
Colorado	1 5-inch shell	9/1/45	Minor damage
West Virginia	1 kamikaze	1/4 /45	Minor damage
Maryland	1 kamikaze	7/4/45	Minor damage
Tennessee	1 kamikaze	12/4/45	Moderate damage

Since they were designed to fight each other, and designed at the same time, it is useful to compare the Tennessee and Colorado classes with their IJN counterparts. The *Tennessee*'s Japanese counterpart was the two-ship Hyuga class, which was also the IJN's last 14-inch battleship; these were completed in December 1917 and April 1918. The Tennessee class was a clearly superior design with a better main battery arrangement than the six twin-turret arrangement on the Hyuga class. The Tennessee class four-turret layout created larger firing arcs and decreased the length of the ship thus limiting the area that needed to be protected. This translated into a thicker main belt, and a greater scale of protection for the barbettes, main turrets, and conning tower. Even more pronounced was *Tennessee*'s more effective torpedo protection system, though this advantage was lessened when the two Hyugas received a torpedo bulge in 1934–37.

Both classes carried 12 14-inch guns, but the American ships enjoyed a better arrangement and superior firing arcs. Both classes were equipped to fight a long-range gunnery duel, and the 43 degree maximum elevation of the turrets on the Japanese ships gave them a slightly superior range. The prospects of hitting a target at the maximum range of 38,770 yards were very remote, so this was a theoretical advantage only. The USN's incorporation of radar into the fire-control system of its battleships made the Tennessee class far superior gunnery platforms as was shown at Surigao Strait. The Japanese advantage was in the area of speed, which was even more marked after the Hyuga class's modernization which raised its speed to 25 knots.

The same basic comparison holds for the Colorado class when matched against the Nagato class. Both ships carried eight 16-inch guns with the Japanese having a theoretical maximum range advantage. Both navies used equivalent fire-control technologies, until the USN surged ahead during the war by adding radar. The Colorado class was better protected, though this edge narrowed from 1934 to 1936 when the Nagato class was modernized. Again, the Japanese ships enjoyed a significant speed advantage with a maximum speed of 25 knots.

This same trend would have been apparent had the South Dakota class been completed. In fact, they would have been the most balanced and powerful battleships in the world. Compared to the two ships of the uncompleted Kaga class, the USN ships had superior firepower and protection, and only a slight speed disadvantage. On the other hand, the Lexington class was a poor design which would have compared unfavorably with the IJN's Amagi class battlecruisers. The American ships sacrificed speed for protection and were underarmed compared to the Japanese ships. It was better that they were not completed and the conversion of two of the battlecruisers into aircraft carriers gave the USN a much greater return.

In the final analysis, the ships of the Tennessee and Colorado classes proved adaptable and therefore successful in their emergent primary role as gunfire-support ships for amphibious operations. When they engaged the IJN, they performed well on the one occasion they were called upon to do so. Against the kamikaze threat they were difficult to knock out of action. While the IJN's battleships sheltered in harbor waiting for a decisive battle which did not occur until October 1944 when it was too late, the USN Standard-type battleships had active careers for the last 20 months of the war, paving the road to Tokyo through the islands of the Pacific.

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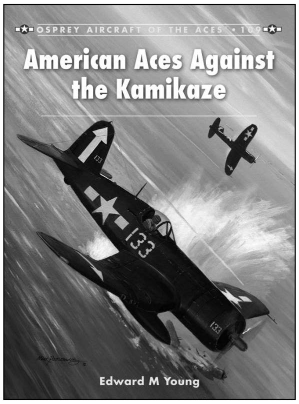
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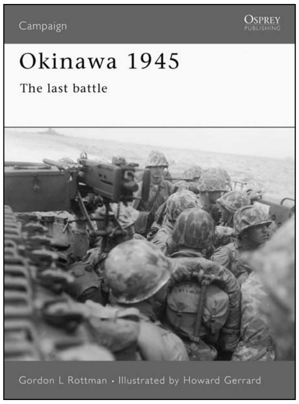
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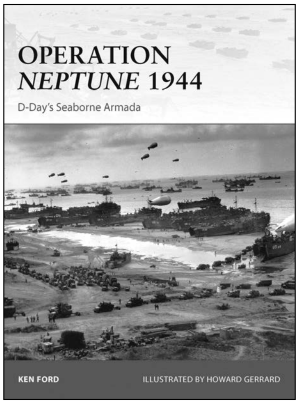
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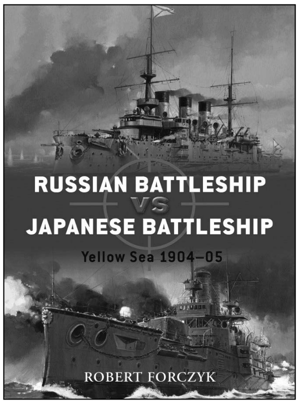
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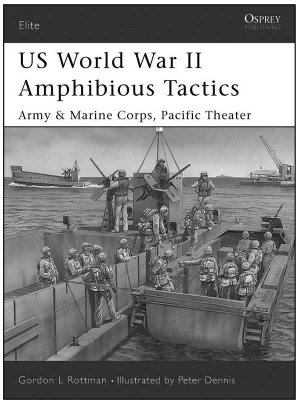
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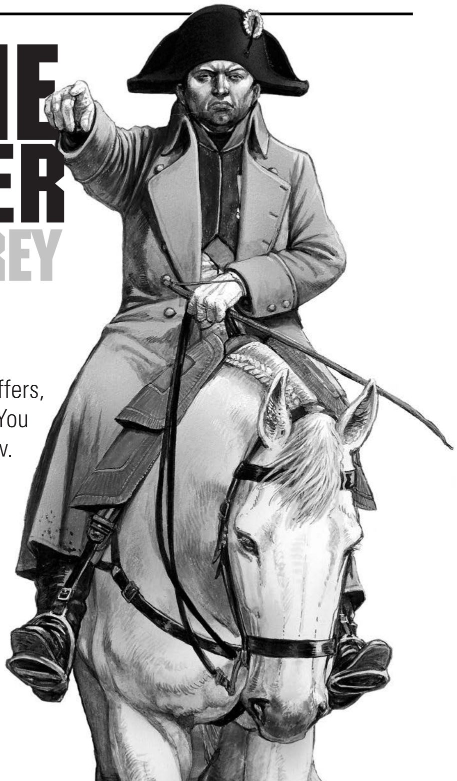

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